THE GENUS *ODONTACARUS* (ACARINA: TROMBICULIDAE). II. OBSERVATIONS ON THE LIFE HISTORY AND MORPHOLOGY OF *ODONTACARUS SWANI* N. SP., AND RELATED FORMS

by

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ABSTRACT

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The ovum, larva and adult of *Odontacarus swani* n. sp. are described, being the first recorded correlation between adults and larvae in *Odontacarus*. However, as is customary in this group, a larva has been selected as the type.

A key is given for all species described as larvae from Australia, New Guinea and South East Asia.

A correlation analysis is made of the dimensions of the chitinized parts (scutum, setae and leg segments) of the type series of *O. swani*. A principal component analysis defined two components, both of which include variates derived from the dorsal scutum and the leg segments.

A similar analysis is made for the larvae of two other species of *Odontacarus*: *O. athertonensis* (Womersley, 1945) from north Queensland, and *O. mccullochi* (Womersley, 1944) recorded from north Queensland (and Papua New Guinea). In each of these species two principal components of correlation are defined which are not completely duplicated in the other two species. All four of these components include variates based upon scutal dimensions, three of them include variates based on leg segmental lengths, and two of them (each of these latter being the second principal components) include variates based on lengths of idiosomal (body) setae. Some components contain also variates derived from body hair dimensions.

It is concluded that no standard components can be defined and in general there is not a high degree of correlation between the various standard (and other) variates customarily used in the classification of the larvae of the genus *Odontacarus* (family Trombiculidae), in agreement with my earlier study of *Trombella* where another group of correlated variates was defined. This contrasts with similar analyses of hard structures (such as bone) of vertebrates.

Additional morphological details are given for the Australian species of *Odontocarus, O. cooki* (Southcott, 1957), *O. langani* (Southcott, 1957), *O. mathewi* (Southcott, 1957), and *O. southcotti* (Womersley, 1944) to help construct the key of the larvae and for *O. barrinensis* (Womersley, 1945). Amended collection data are provided for *O. southcotti*.

A key is given for the adults of *Odontacarus* (all known adults are Australian) and the adult *O. swani* is described.

Acomatacarus retentus (Banks, 1916), known from only the original material from Victoria, is made the type of *Scopitrombium* n. gen., in the Leeuwenhoekiinae. A lectotype is designated, and the species redescribed.

Revised keys are given for the subfamilies of Trombiculidae, and for the genera of the subfamily Leeuwenhoekiinae for both adults and nymphs.

INTRODUCTION

The genus *Odontacarus* was founded by Ewing (1929b, pp. 22, 188) with the following definition:

"Each chelicera with a row of backwardly directed teeth on the upper margin of chela, and some upturned teeth on the lower margin (Fig. 16). Palpal claw bifurcate, the two divisions unequal. Dorsal plate without median anterior process and with only five setae in addition to the pseudostigmatic organs, which are flagelliform and pectinate.

Type: *Trombicula dentata* Ewing".

Ewing's species was based upon two larvae: "Described from two specimens; one, the holotype, from Sonora, Texas (Bish. No. 10681), taken by O. G. Babcock, December 17, 1922 on a white-tailed deer and the other from Balboa, Panama on a cotton rat by L. H. Dunn". He figured (1925a, p. 258) only the right chelicera of the holotype (Cat. No. 888, U.S.N.M.).

In founding *Odontacarus* Ewing (1929b, p. 188) compared it with the larvae then attributed to *Trombicula* Berlese 1905 (described originally from the adult) and to the larvae of *Schöngastia* Oudemans 1910, and saying "only the type species included", i.e. *T. dentata* Ewing, 1925. He made no reference to the larval genus *Leeuwenhoekia* Oudemans, 1911.

In 1942 Ewing revised the taxonomy of some of the American mites ('chiggers') then placed in the subfamily Trombiculinae Ewing, 1929 (1929b, p. 22). He (1942, p. 489) decided to divide the genus *Leeuwenhoekia*, and erected two new genera, *Comatacarus* and *Acomatacarus*. The latter he founded for the larval *A. arizonensis* Ewing, 1942, defining it as:

"Most nearly related to *Comatacarus* [Ewing, *loc. cit.*, p. 489] but differing from it as follows: Chelicera with a row of teeth on upper margin instead of a single

tooth and both the first [palpal femorala] and second [palpal genuala] palpal setae simple instead of one or both being plumose or barbed".

The principal distinguishing characters of *Comatacarus* (from *Leeuwenhoekia*) were (Ewing, 1942, p. 489) "in having the posterolateral setae of the dorsal plate of the usual form and similar to the anterolateral, instead of being clavate, and in having a large number of sessile setae on the dorsum of the abdomen, instead of a small number situated on the tubercles".

Ewing (1946, p. 436), in a further revision of the trombiculid mites (raised to the family Trombiculidae by Ewing in 1944), redefined *Odontacarus* and stated:

"*Odontacarus* is related to *Acomatacarus* Ewing, 1942, from which it differs in having a single median seta on the dorsal plate instead of two submedian setae. It is also related to *Endotrombicula* Ewing, 1931 [See Wharton and Fuller (1952, p. 72) and Audy (1954, p. 160) for opinions on the present status of this genus.]. . .": he included in *Odontacarus* also *O. australis* (Ewing, 1929), which was described (1929a, p. 10) from several specimens collected on the lizard *Tropiduras peruvianus* at Verrugas Cañon, Lima, Peru, 15.iv.1928, R. C. Shannon, Cat. No. 987, U.S.N.M.

Brennan (1959) stated that *Trombicula dentata* Ewing, 1925 was based on a single teratological specimen, possessing a single anteromedian scutal seta instead of the normal two, commenting that this holotype specimen is in a distorted and damaged condition, with most diagnostic features hard to determine. Nevertheless he stated that "The AM [seta] is slightly to the right of center", and declared that "there is no doubt whatsoever as to its generic status", even though its "specific identity . . . is in question".

With regard to the second larval specimen assigned by Ewing originally to *T. dentata*, Brennan (1959, p. 2) has commented that it is "damaged beyond recognition and reclaim . . . It seems incomprehensible, however, that this specimen could possibly have been regarded as conspecific with the holotype".

As far as *O. australis* (Ewing) is concerned, Brennan (1959) redescribed the holotype briefly, without figures, stating that this specimen also had a teratological dorsal scutum—"In each [of the two holotypes], the left AM is lost; thus the specimens are freaks". Two other specimens, each labelled by Ewing as a "cotype", were identified by Brennan (*loc. cit*) as *Eutrombicula alfreddugesi* (Oudemans, 1910).

However, eventually *O. dentatus* holotype was found not to be teratological after all; Goff *et al.* (1972) were able to see two AM seta bases, using phase microscopy, although the setae were not attached (Goff and Loomis, 1977).

Wharton and Fuller had earlier (1952, p. 103) realized the probable synonymy of *Odontacarus* and *Acomatacarus*, but had commented, with reference to *Odontacarus*: "Specimens in existence are too badly damaged to study satisfactorily". These remarks applied to both *O. dentatus* and *O. australis*.

It appears strange that Ewing had not at this stage seen the characteristic feature of the leeuwenhoekiinae shield, an anteromedian tongue-like projection to the dorsal scutum, in fact stating specifically that it was absent (see his definition of *Odontacarus* above). Although Oudemans had described this feature in *Leeuwenhoekia verduni* (Oudemans, 1910) as early as 1910 and 1911, and again in his 1912 monograph, apparently it was not observed by Ewing and published until his 1942 paper for *Acomatacarus* and *Comatacarus*. However, in his key to the larval Trombiculinae, Ewing (1938, p. 291) showed that he was aware of the anteromedian process in *Leeuwenhoekia* Oudemans, but again failed to record it for *Odontacarus*.

Comatacarus Ewing was reduced to subgeneric status (in *Leeuwenhoekia*) by Wharton *et al.* (1951), followed by Wharton and Fuller (1952, p. 96), Gould (1956), Loomis (1956), and Finley (1958), but restored to full generic status by Reed (1973) and Goff and Loomis (1974).

Acomatacarus Ewing, 1942, was resurrected by Vercammen-Grandjean (1968, p. 122), and in its new generic status was divided into subgenera by the same author—*Acomatacarus* subgen., and *Orochlorus* subgen. (Vercammen-Grandjean, *loc. cit.*).

Odontacarus has been divided into the subgenera *Tarsalacarus* and *Leogonius* by Vercammen-Grandjean (1968, pp. 120-121). *Acomatacarus* Ewing, 1942 includes several subgenera: *Xenodontacarus* Loomis and Goff (1973) (a new name for *Xenacarus* Greenberg, 1951, on grounds of pre-occupation by *Xenacarus* Kishida, 1925), *Metacarus* Vercammen-Grandjean, 1956 and *Orochlorus* Vercammen-Grandjean (1968, p. 122. The last has been synonymized with *Tarsalacarus* by Goff and Loomis (1977), since the type species, *Acomatacarus micheneri* Greenberg, 1952, actually belonged to *Odontacarus*, with the characters of *Tarsalacarus*, which had page priority.

The genera *Austracarus* Lawrence, 1949 and *Hyrocarus* Lawrence, 1949, which were placed as subgenera of *Acomatacarus* by Vercammen-Grandjean (1957), are now considered by the same author (1973a), without giving any explanation, to be full genera in the Leewenhoekiinae.

With the restriction of the genus *Odontacarus* and its separation from *Acomatacarus*, the only subgenus of immediate concern here is *Leogonius*, in which the Australia-New Guinea species considered here and *O. audyi* (Radford, 1946) are placed (see Vercammen-Grandjean, 1968; Goff, 1979a, b).

The genus *Odontacarus* as at present accepted is a widespread one, with species in North and South America, Asia, New Guinea and Australia. In the present paper the term will be used in the sense of Goff (1979a, b).

Most studies of *Odontacarus* species have been based on larvae, as in that instar they are readily collectable as parasites upon vertebrates, including, in some instances, man. At times they are captured from a free-living state, e.g. upon cards, boots, fence posts, etc. In a few Australasian species rearings have been achieved from larvae to nymphs. These were *O. australiensis* (Hirst), from Hollandia, former Dutch New Guinea (now Dyayapura, West Irian), reared by C. B. Philip, and *O. longipes* (Womersley, 1945) (synonymized with *O. novaguinea* by Goff (1979a, p. 149)) from the Dobadura area of New Guinea, and *O. nova-guinea* (Wom., 1944), from "New Guinea", these last two having been reared by G. M. Kohls. These rearings were recorded by Womersley (1945), and allowed him to define the post-larval characters of the genus (then *Acomatacarus*). Later larva to nymph rearings have been achieved by Domrow (1956) for *O. australiensis* in Queensland, and by Nadchatram (1963) for *O. audyi* (Radford, 1946) in Malaysia. The experimental rearings reported in Womersley (1945) allowed him to assign four species of adult trombidioid mites to the genus, these being *O. attolus* (Banks, 1916) from Sydney, New South Wales, *O. dromus* (s. str.) (Womersley, 1939), from Long Gully, South Australia, *O. patrius* (Wom., 1945), from Murray Bridge and Burra, South Australia, and *O. retentus* (Banks, 1916), from Lal Lal, Sea Lake and Ocean Grove in Victoria. Despite the widespread geographical distribution of the genus, and the fact that the larvae may be at times locally numerous, so far all adults that have been recognized as belonging to the genus are of Australian origin. Hitherto there has been no record of a correlation by rearing between an adult of this genus and a larva.

In 1944 I was able to make records of oviposition by adults of *O. swani* n. sp., collected in north Queensland, and to rear larvae from these eggs. The present paper describes these experiments and also the adult, larva and ovum.

Since the great majority of taxa among the Leeuwenhoekiinae and other chigger mites of the family Trombiculidae have been based on the larvae, one of the reared larvae is selected as the type of the species.

I have taken the opportunity to examine the taxonomic status of some species of the genus from Queensland and New Guinea, and to give a key to the larvae of *Odontacarus* known from New Guinea and South-East Asia. However it should be pointed out that this paper does not undertake a general taxonomic review of the larvae of *Odontacarus*, subgenus *Leogonius*, but considers only what is required to establish the new taxon proposed, and for the majority of the species considered in the key it relies on the data of previous authors.

One species of adult allotted to this genus by Womersley (1945) is markedly distinct from the others, this being *O. retentus* (Banks, 1916), and for it a new genus *Scopitrombium* is proposed.

Revised keys are given for the classification, for adults and nymphs, of the subfamilies of the Trombiculidae, and the genera of the Leeuwenkoekiinae.

All measurements are given in micrometres (μm) unless otherwise stated.

SYSTEMATICS

Odontacarus Ewing

Synonymy

(Note: Only a partial synonymy is given here. For earlier and more complete lists of synonymies, see Wharton and Fuller (1952), Audy (1954), Goff and colleagues (1974-1979)).

Odontacarus Ewing, 1929b, p. 188; 1931, p. 6; 1946, p. 436. Fuller, 1952, p. 228. Wharton and Fuller, 1952, p. 103 (ad part.). Vercammen-Grandjean, 1968, p. 120. Loomis and Crossley, 1963, p. 381. Nadchatram, 1963, p. 535. Southcott, 1973, p. 46; 1976, p. 139; 1978, p. 16. Reed and Brennan, 1975, p. 6. Goff and Loomis, 1977, p. 370. Goff and Brennan, 1978, p. 50. Goff, 1979a, p. 143; 1979b, p. 140.

Leeuwenhoekia (Oudemans, 1911) Hirst, 1925, p. 150. Womersley, 1934, p. 217; 1944, p. 103. Womersley and Heaslip, 1943, p. 141. Taylor, 1946, p. 227 ff.

Acomatacarus Ewing, 1942, p. 490. Womersley, 1945, p. 98. Taylor, 1946, p. 225. Greenberg 1951, p. 525; 1952, p. 473. Fuller, 1952, p. 229. Gunther, 1952, p. 39. Wharton and Fuller, 1952, p. 96. Audy, 1954, p. 164. Baker *et al.*, 1956, p. 104. Domrow, 1956, p. 150. Southcott, 1957, p. 146; 1973, p. 103; non Vercammen-Grandjean, 1968.

Odontacarus swani n. sp.

Description of adult female (principally from specimen ACB240A, slide-mounted, somewhat compressed; but supplemented by other specimens) (Figs. 1A-E; 2).

Colour in life red. Idiosoma (Fig. 1A) of normal ovoid shape for a trombidioid mite, without waist, and without division between prosoma and opisthosoma; length on slide about 1400 μm (all measurements in micrometres), width about 900.

Prosoma carries dorsally a well-chitinized crista, with an enlarged posterior end, carrying two sensillary setae (Fig. 1B). The crista tapers anteriorly, to a blunt-pointed rod, embedded in an arrow-shaped area of chitinization (here named the "sagitta" since the term "tectum" used by Crossley (1960) for this part of the scutum is considered less appropriate.). The crista is surrounded by the normal dorsal setation, sparser around anterior end. The sagitta carries two long, thin, ciliate setae (Figs. 1B, 1E). Crista 343 long from its blunted anterior point to rear edge of the posterior sensillary boss; 423 long to tip of sagitta. Behind posterior sensillary boss the crista continues for a further 70, to end in a blunted point. Sensillary boss 94 across, distance between centres of sensillary setae bases (i.e. "SB") 57. Sensillary setae slender, long,

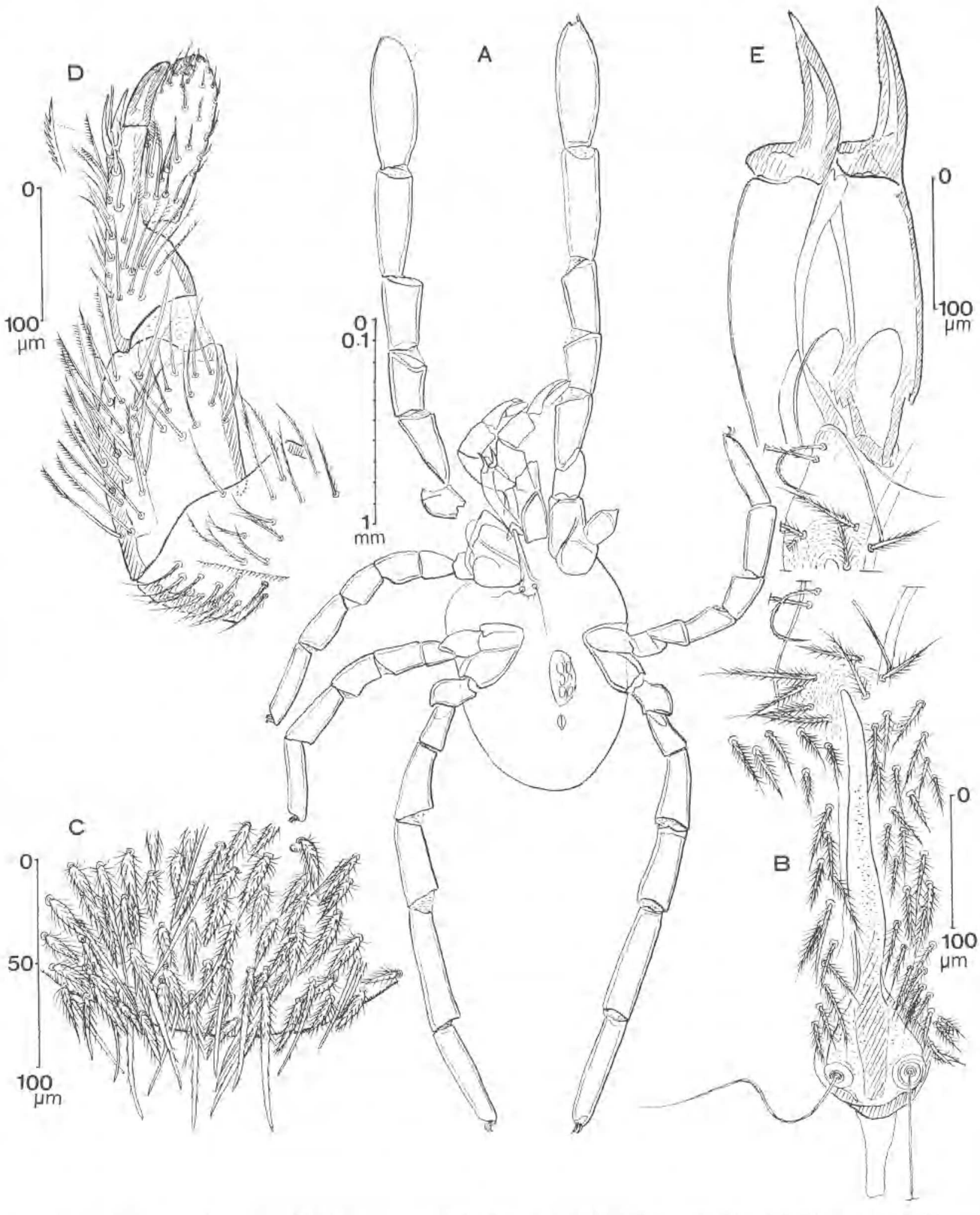

FIG. 1. *Odontacarus swani* sp. nov. Adult female, specimen ACB240, parent of the holotype. A Entire specimen, slide-mounted, seen in transparency. B Crista and adjacent area. C Dorsal setae at posterior pole of idiosoma. D Left palp, medial aspect. E Chelicerae. (All to nearest scale.)

filiform, 290 long. The chitin of crista, including that of the area between the sensillary sockets, punctate.

The whole of dorsum of idiosoma is densely covered with setae mounted on short papillae. The setae tend to be separable into two distinct types—a shorter burr-like, spindle-shaped, pointed, heavily ciliate group, mostly 27-31 long, and interspersed among these are longer, swordlike setae, in which the proximal part of the scobillum is somewhat expanded and ciliate; but the distal half is curved, swordlike, curved and pointed, with adnate cilia along the edges: a batch of these setae at the posterior pole of the idiosoma is illustrated in

Fig. 1C. There is, however, some intergrading between these two main types of dorsal idiosomalae; at the posterior pole the longer swordlike setae are 64-73 μm long, the shorter spindle-shaped setae 25-42 long. At the centre of the dorsum the longer setae are 56-95 long, the shorter setae 27-44 long.

Eyes are not visible in any of the specimens of adults available, and it must be concluded that they are absent (despite being present and normal in the larvae).

Ventral surface of idiosoma is covered with a dense setation of spindle-shaped, tapering, heavily ciliate setae. These tend to be uniform, similar to the shorter dorsal idiosomalae, except towards the posterior pole, where they are interspersed with swordlike setae similar to those of the adjacent dorsum.

Genital aperture in usual position, about 390 long by 255 across, with three oval suckers along each side.

Anus normal, 91 long by 46 across.

Legs long, but robust for a trombidioid mite, moderately chitinized; trochanters generally rounded, basifemoral, telofemoral and genual segments presenting as truncate cones, tibiae and tarsi approximately cylindrical. Leg lengths (including coxae and claws): I 2660, II 1760, III 1770, IV 2640. Each tarsus bears two claws. Legs well covered with numerous fine, pointed, lightly ciliate setae (scobalae), these being interspersed in the distal segments with pointed, specialized sensory setae (spinalae, or eupathidalae).

Tarsus I an elongate oval, 634 long by 214 across, wider than tibia I, which is 534 long by 178 across; tarsus II 397 long by 93 high; tibia II 313 long by 121 high; tarsus III 399 long by 85 high; tibia III 352×128 similarly; tarsus IV 523×114 similarly; tibia IV 627×157 similarly. For other leg morphometric data, see Table 1.

TABLE 1. MEASUREMENTS (μm) OF SOME CHITINIZED PARTS OF EIGHT ADULTS OF *ODONTACARUS SWANI* N. SP.

Character	*Range*	*n*	*Mean*	*S.D.*
Crista length[1]	277-343	8	321.75	57.42
SB	34-63	8	52.87	23.89
Tal[2]	585-634	7	603.14	48.36
Til	499-548	7	517.29	46.17
Gel	332-368	7	344.14	32.45
TalV[2]	435-523	7	488.71	72.91
TilV	506-627	7	574.00	94.95
GelV	370-427	7	390.29	53.27

[1] Measured from anterior end of chitinous rod to posterior pole of sensillary boss.
[2] Omitting claws and pedicle.

Palpi comparatively slender, well covered with ciliate setae (see Fig. 1D). Many of these scobalae along the dorsal (i.e. extensor) margins of the palpal genu and tibia are ciliate along their distal and outer aspects, the cilia broad and flattened, curved, uniform and almost apposed, as though capable of being touch receptors utilizing a mechanism akin to stridulation; for these setae the term *pectinala* is proposed (plural: pectinalae). Palpal tibial claw stout, blunted, with four accessory claws (thickened scobalae) on the medial to dorsal aspects.

Palpal tarsus an elongate ovoid, with numerous ciliate setae (scobalae); these setae tend to resemble the palpal tibial and genual pectinalae, but are shorter. Among them are also nude setae (spinalae) and pectinalae. A cluster of short sensory setae is present at the tip of the palpal tarsus.

Chelicerae robust; fangs curved, pointed, about 135 long, with a row of about 10 fine retrorse teeth along distal flexor edge; extensor edge smooth. Chelicera basis about twice as long as fang. Rostrum (cone) of mouthparts with numerous ciliated, tapering setae.

Taxonomic placing: In the key of Womersley (1945, p. 110) this adult keys to the caption for *O. dromus* (Wom., 1939). From that species *O. swani* may readily be separated as follows:

Colour of adult mite red. Longer dorsal idiosomal setae with long cilia in the basal half, and with aduate cilia, scarcely detectable, in the distal half of the seta. Shorter dorsal idiosomal setae strongly ciliate, spindle-shaped, tapering ..... *O. swani* n. sp.

Colour of adult mite white in life. Longer dorsal idiosomal setae ciliate throughout length. Shorter dorsal idiosomal setae slender, uniformly ciliate .... *O. dromus* (Wom.)

Further comments on the taxonomy of adult leeuwenhoekiine mites are made later in this article.

Description of Ovum

(Fig. 2, 3A-D) (from mounted material)

Colour in life not observed. Ovum nearly spherical to somewhat spheroidal, about 250-350 long in longest diameter. Ovum has the usual lightly pigmented outer layer (chorion), which is smooth, lacking any striate markings in the available material. Minute tuberculations occur on the parts of the mounted material, but these could be, at least to some extent, results of compression in eclosion, or rupture by other means.

The sole embryo available (Fig. 3D) is about 280 long in its greatest diameter, by about 220 wide in its shortest diameter. It contains a large number of rounded granules, presumably of yolk, mainly concentrated in the region opposite to that in which the limbs are developing. Two annuli (seta bases) are present in the specimen, and two tooth-like structures, possibly shell-piercers in eclosion ("t" Fig. 3D). From one annulus there is a vague indication of a developing seta shaft. On the developing limb segments are smooth, rounded, low tubercles, similar to those recorded for *Trombella alpha* developing nymph (Southcott 1986a, Fig. 5A).

One chorion (Fig. 3C) is unusual in being covered randomly with small circular or oval lacunae. In rupturing, presumably from eclosion, some of these lacunae have been cut across transversely; it is clear that they were present before rupture, and presumably in life. No evidence of mould filaments or other possible chitinolytic agents can be seen near them, and their origin is unknown. Under polarized light a few of them

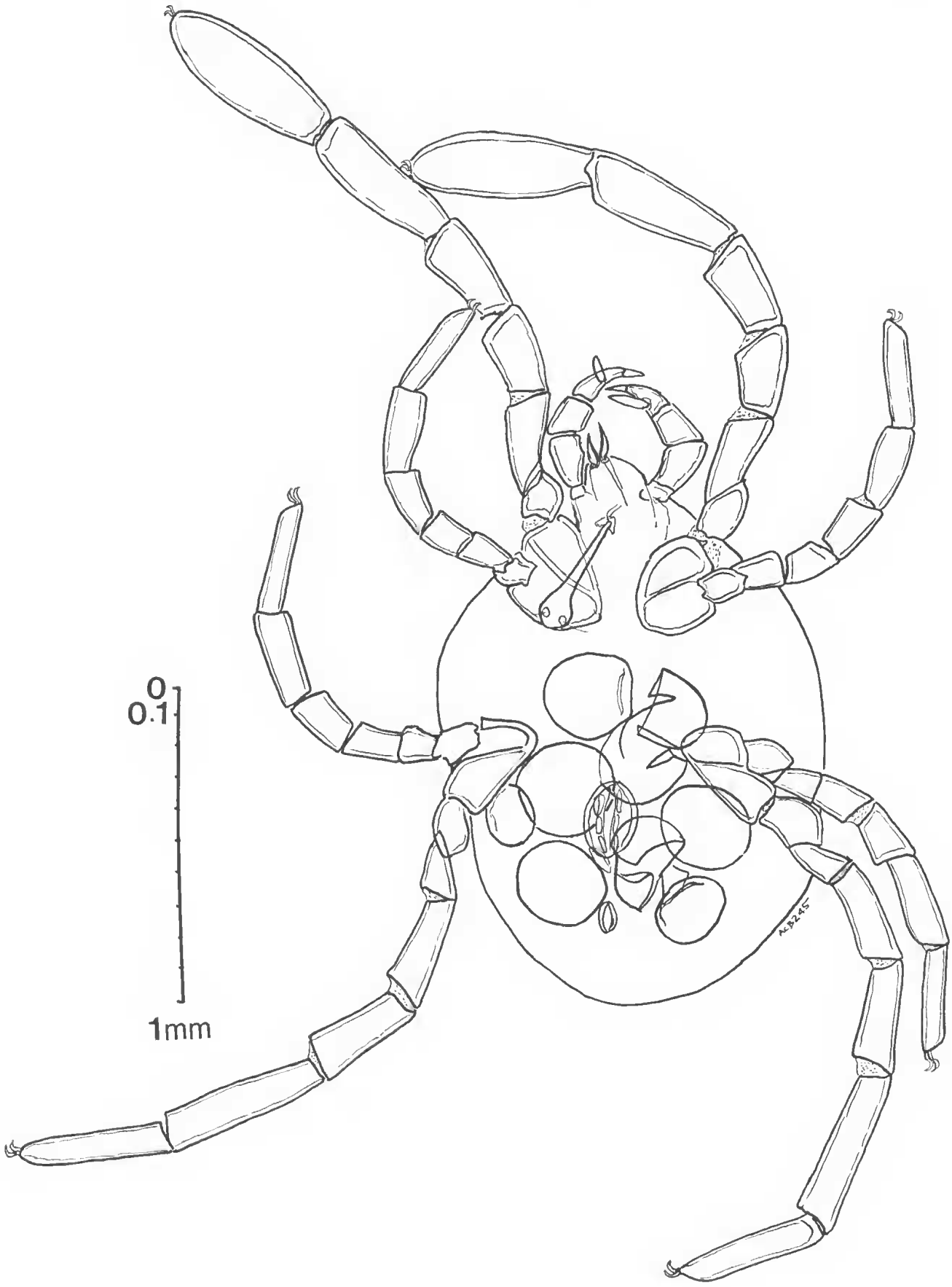

FIG. 2. *Odontacarus swani* sp. nov. Adult female, specimen ACB245, seen in transparency. The idiosoma contains nine eggs, of varying sizes, some having been disrupted by the mounting process.

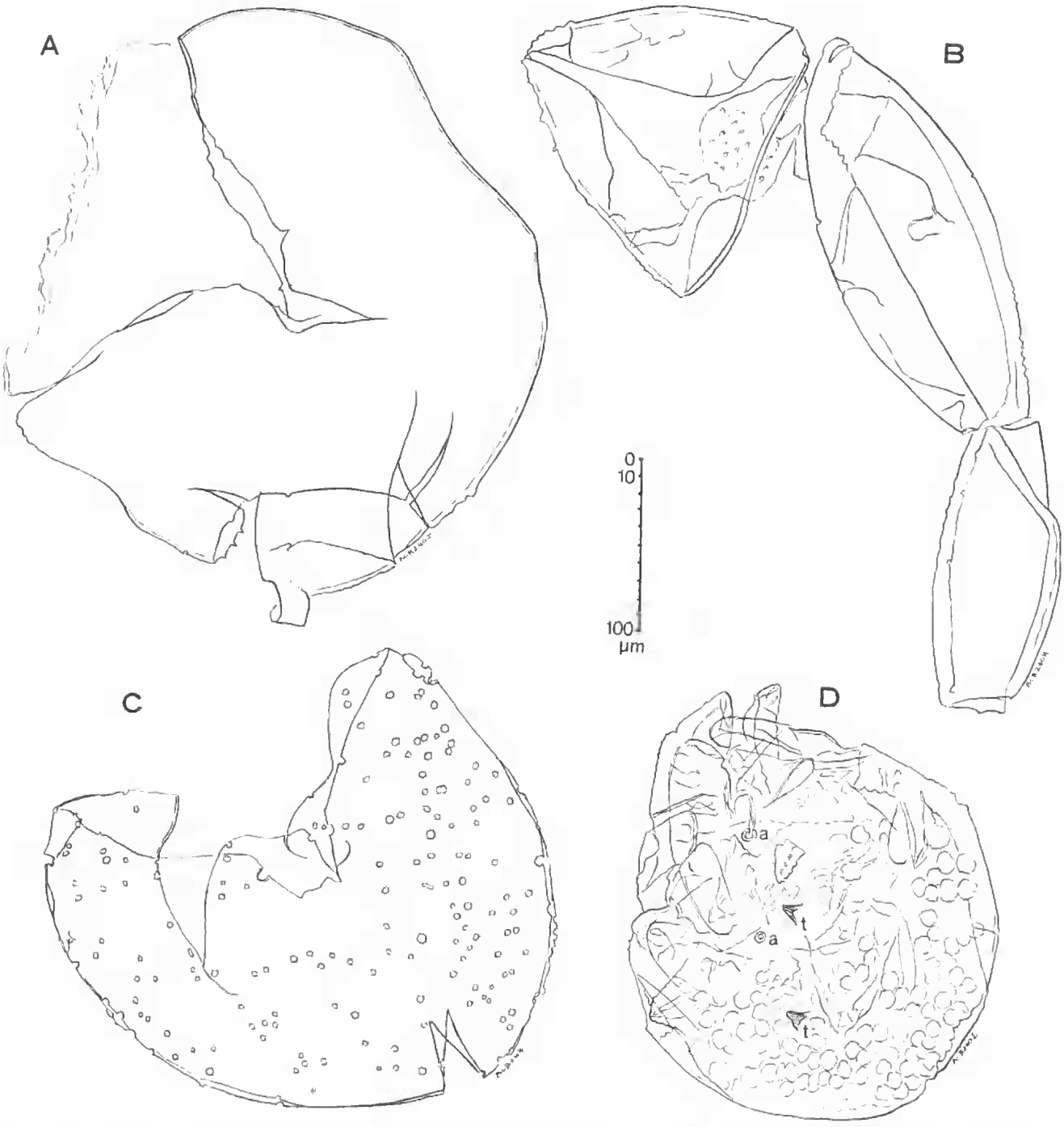

FIG. 3. *Odontacarus swani* sp. nov. Ova, slide-mounted specimens. A Ruptured ovum, showing chorion. B Chorion of another ovum split into three pieces, and possibly some of the developing embryo. C A ruptured chorion with multiple lacunae (see text). D Developing embryo, shed from its chorion, with early development of limbs and other structures: a annulus or seta base, t tooth-like projection (see text). All specimens shown in transparency. (All to scale shown.)

show a typical Maltese-cross figure, indicating that there is possibly a layer of optically active material at the base of the lacuna, perhaps an artefact of the mounting. The chorion shows only weak evidence of optical activity under crossed polarizers.

Description of Larva (from reared specimen ACB240B, holotype, and supplemented by other specimens) (Figs. 5A-D, 6A-C).

Colour in life red. Length of idiosoma (mounted on slide) 207, width 197; total length of animal from tip of cheliceral fangs to posterior pole of idiosoma 293.

Dorsal scutum slightly wider than long (including nasus). Although most authors measure the length of the dorsal scutum ("S.D." or shield depth) of *Odontacarus* larvae (and other genera of the Leeuwenhoekiinae in which there is a distinct beak-like "nasus" to the scutum) excluding this "nasus", a comparative study of allied forms, e.g. *Neotrombidium* larvae, as well as larval *Trombella* (see Southcott, 1986a), shows that the "nasus" may range from a broad continuation of the scutum, without clear point of differentiation, to a distinct and sharply demarcated beak. The length

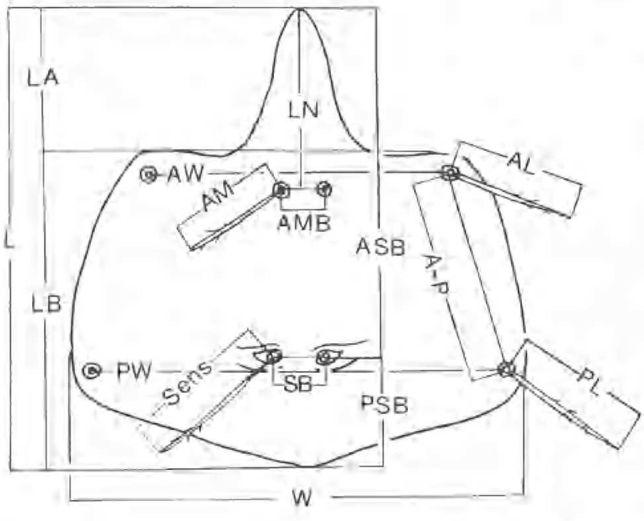

FIG. 4. Conventions of measurements of dorsal scutum of a leeuwenhoekiinae larva, as used in the present article (see text).

TABLE 2. MEASUREMENTS (μm) OF REARED *ODONTACARUS SWANI* N. SP. LARVAE

Character	*Holotype*	*Range*	*n*	*Mean*	*S.D.*
AW	65	65-73	8	69.13	3.271
PW	78	77-83	8	80.88	3.271
SB	27	25-30	8	26.75	1.669
ASB	49	49-57	8	53.13	2.949
PSB	33	22-33	8	30.25	3.536
L	82	77-87	8	83.38	3.462
LA	18	17-22	8	19.13	1.727
LB	64	55-69	8	64.25	4.432
LN	25	27-35	8	30.25	3.495
W	85	85-97	8	91.63	3.739
A-P	25	24-29	8	26.13	1.552
AM	41	35-43	8	38.88	2.900
AL	47	46-55	8	48.63	3.159
PL	55	55-62	8	59.50	2.507
AMB	11	11-13	8	12.00	0.926
Sens	51	48-55	—	—	—
PW/LB[1]	1.22	1.20-1.31	—	—	—
DS	36-47	(36-44)-(47-51)	—	—	—
mid-DS	36-44	(36-44)-(44-51)	8	46.25[2]	2.188[2]
PDS	38-47	(38-46)-(47-51)	8	49.13[2]	1.727[2]
GeI	46	41-51	8	47.25	3.012
TiI	55	54-57	8	55.25	0.886
GeII	38	38-45	8	40.63	2.264
TiII	46	44-54	8	47.50	2.264
GeIII	43	43-48	8	46.25	1.581
TiIII	57	57-63	8	59.63	2.066

[1] This is the PW/SD of Womersley (1944, 1945) and the PW/L of Greenberg (1951) (see Fig. 4, and text explanation).
[2] For the maximum values of each variate.

(L) is taken here as including the "nasus". However, in order to make the measurements comparable between different workers, measurements are offered here of the shield length including "nasus" (L) and without "nasus" (LB) (see Fig. 4 for explanation).

Nasus well-developed, running into more or less straight (slightly sinuous) anterior margin; lateral borders slightly convex; posterolateral convex, of varying curvature; AM setae tapering, pointed, lightly ciliate; AL and PL similar. Sensillary setae normal, ciliate in distal half or third. Sensillary sockets about level with PL bases, sloping obliquely anterolaterally, and with well-marked margins ("lids").

The standard (and other) data for this specimen, as well as other reared material, and the Type series and other identified material in the South Australian Museum Collection are given in Table 2.

Eyes 2+2, sessile, near PL angles of dorsal scutum, oval. Anterior eye with maximum diameter of cornea 16, posterior 14.

Dorsal idiosomal setae long, moderately ciliate with lightly projecting barbs; setae arranged 6, 12, ..., in vague transverse rows, total in ACB240B, 57.

Venter with a pair of pointed setae between coxae III, ciliate, 33 long. On opisthosoma ventrally about 37 further setae, pointed, well ciliate, 27-42 long, the posterior setae longer and tending to be blunted at the tip, resembling the posterior dorsal idiosomalae.

Coxalae 2, 1, 1. All coxalae long, pointed, ciliate; lateral coxala I 51 long, medial 46, coxala II 44, III — (missing in holotype; 58 long in ACB240C).

Legs normal, I 379 long, II 322, III 380 (all lengths include coxae and claws). Chaetotaxy of legs as figured. Leg scobalae normal, pointed, ciliate. Trochanteral formula 1, 1, 1; femoral 6, 5, 4. Leg specialized setae as follows: VsGeI.70pd ("microseta"), VsTiI.87pd ("microseta"), SoGeI.36pd, SoTiI.90d (i.e. slightly distal to Vs), VsGeII.70d, SoGeII.30d, SoTiII.45d, SoTiII.91d, SoGeIII.29pd. Tarsus I and II have each a large dorsal solenoidala, FaTaII present (see figure). Normal SoTaIII present. Tibia III with two mastisetae (=mastalae): MaTiIII.73d, MaTiIII.76pd. Tarsus III with one mastiseta: MaTiIII.33pd. (In these estimates tarsal length excludes claws and pedicle.) Tarsus I 86 long by 32 across. Tarsus III 85×24. Other specialized leg setae as figured. Other leg measurements as in Table 2.

Tarsal claws normal, falciform, slender, with strong cilia (onychotrichs) on anterior and posterior; middle claw longer and more slender than the neolaterals, with weak cilia.

Gnathosoma normal. Combined chelicerae bases 84 across, chelicerae 89 long from tips of fangs to posterior pole of chelicerae bases. Cheliceral fang stout, curved, pointed, with three of four retrorse teeth along (concave) flexor (dorsal) edge, and 4-5 tuberculations or blunted teeth on (convex) extensor (ventral) edge. Galeala nude, 22 long. Gnathobasal setae (palpal coxalae) curved, pointed, well ciliate, about 24 long.

Palpi compact. Palpal formula 1, 1, 3, 8, with palpal formula B(b), N(?b), BNN, So+7 (B or N), as figured. Palpal tibial claw trifurcate. No supracoxala to legs or palpi.

Origin of Adult Material Studied

I collected ten adults in damp soil in rainforest at Mt Hypipamee, Atherton Tableland, Queensland on 26.x.1944.

Each was placed in a small tube with some damp soil from the capture area, and observed periodically (albeit somewhat irregularly, as I was engaged in military duties). Living larvae were observed in two of the tubes from 20-24.xii.1944 using a 28× Zeiss microscope ocular reversed as a hand lens; in a third

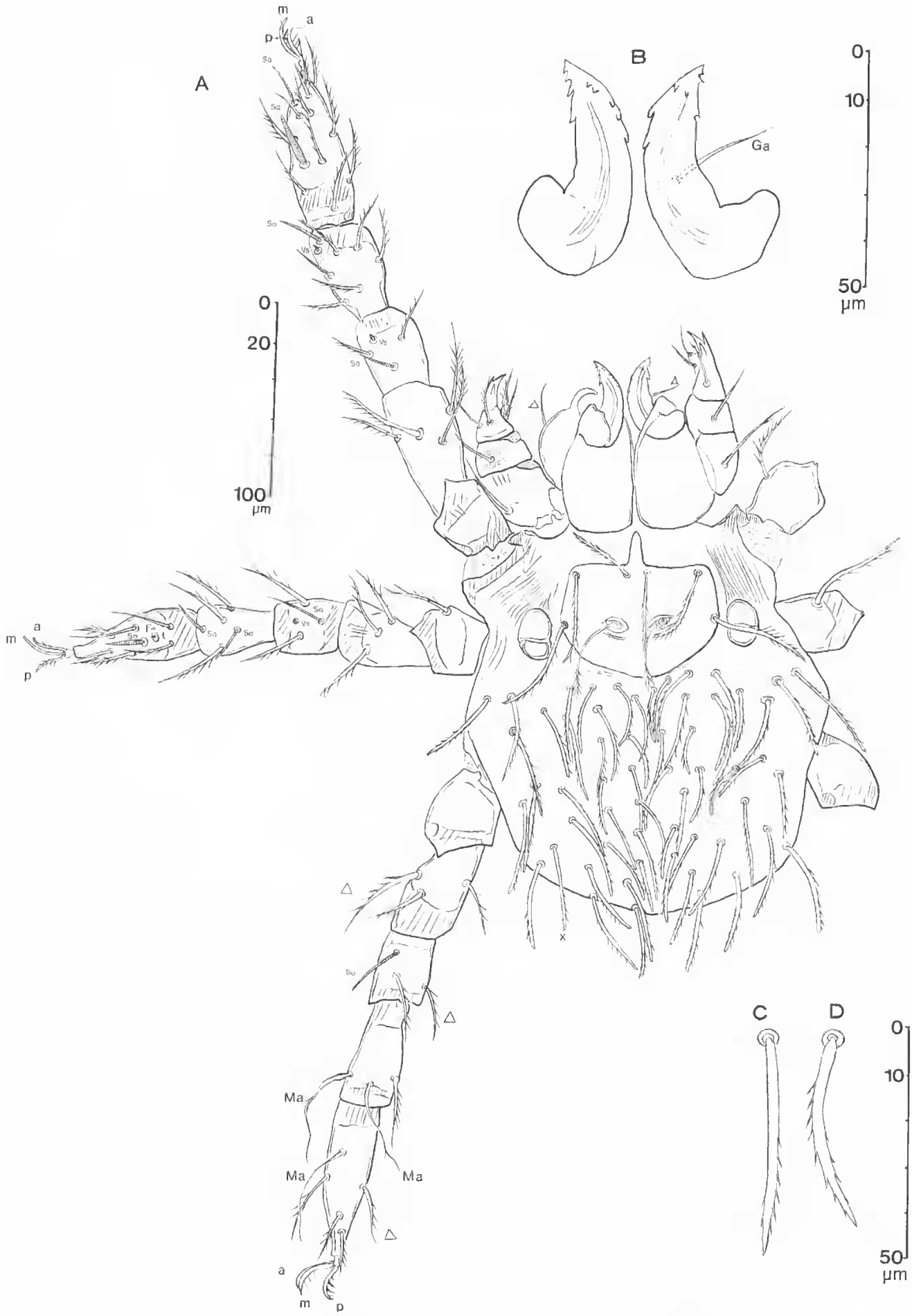

FIG. 5. *Odontacarus swani* sp. nov., larva, holotype, ACB240B. A Dorsal aspect, legs on right hand side omitted beyond trochanters. B Cheliceral fangs and galeala from above (distal half of cheliceral fangs shown in transparency). C Posterior dorsal seta (x in A). D Posterior ventral seta (y in Fig. 6A). (All to nearest scale.) In this and in subsequent figures the △ sign indicates the seta is shown in both dorsal and ventral figures.

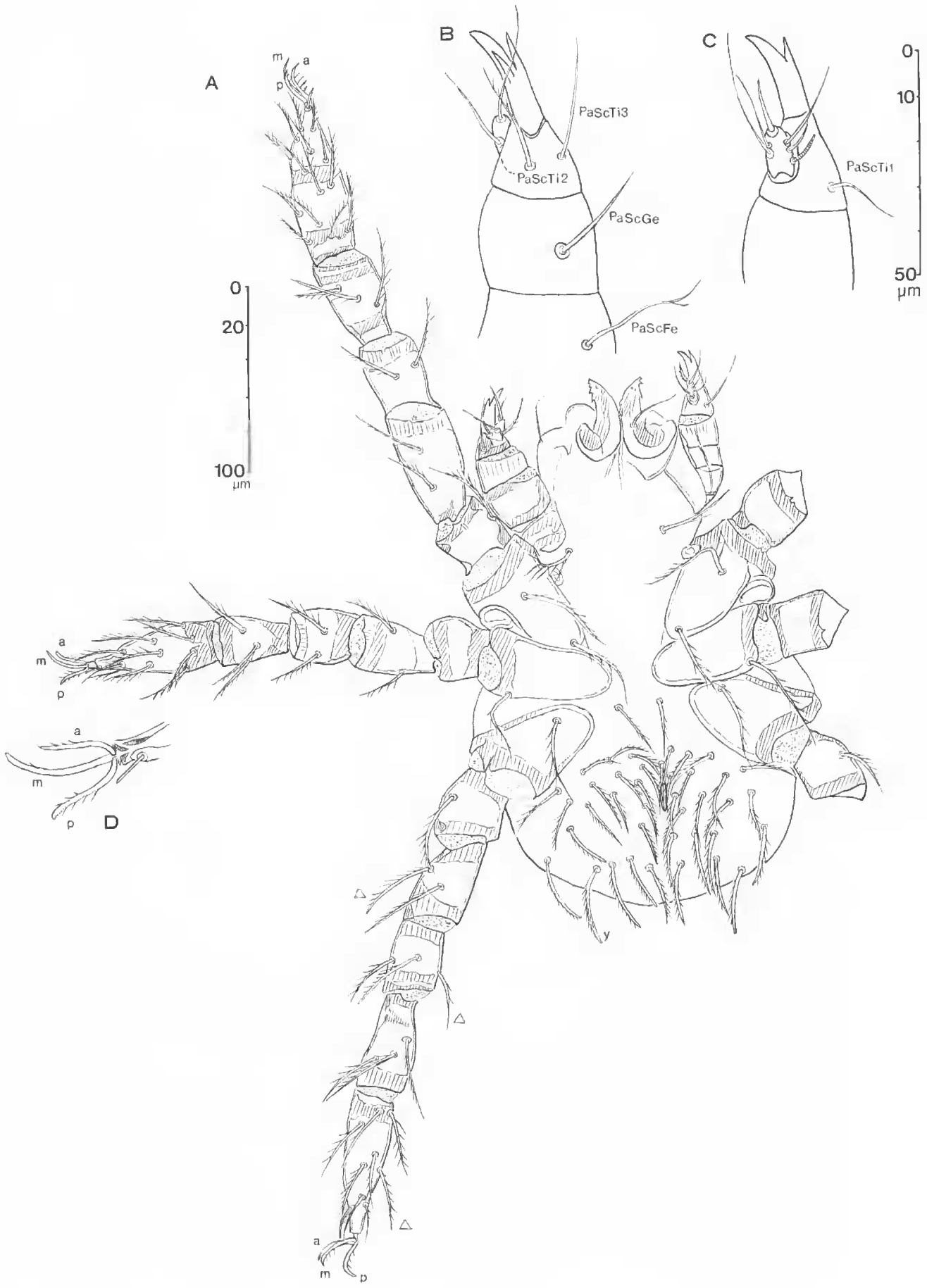

FIG. 6. *Odontacarus swani* sp. nov., larva, holotype, ACB240B. A Ventral view, legs on right hand side omitted beyond trochanters. B Right palp, dorsal aspect. C Right palp, ventral aspect (B, C to scale on right). D Claws of leg II, further enlarged (not to scale).

TABLE 3. DETAILS OF REARING EXPERIMENTS COMMENCING WITH A BATCH OF ADULTS OF *ODONTACARUS SWANI* N. SP. FROM MT HYPIPAMEE, QUEENSLAND, CAPTURED 26 OCTOBER, 1944

Serial No. ACB	*Sex*	*Eggs observed*	*Larvae observed*	*Larvae dead*	*Adult dead*	*Remarks*
238		—	—	—	22.xi.44-20.xii.44	
239	F	(8.vii.45)*	20-23.xii.44	24-30.xii.44	22.xi.44-20.xii.44	
240	F	(8.vii.45)*	20-23.xii.44	24-30.xii.44	22.xi.44-20.xii.44	
241		—	—	—	2-6.xi.44	
242		—	—	—	22.xi.44-20.xii.44	
243	F	—	—	—	17.xi.44-22.xi.44	Gravid, laid no eggs, but body contains about 50 eggs
244	F	(21.v.48)*	(21.v.48)*	—	22.xi.44-20.xii.44	
245	F	—	—	—	ca 6.xi.44	Gravid (9 eggs), laid none
246		—	—	—	22.xi.44-20.xii.44	
247		—	—	—	22.xi.44-20.xii.44	

* These eggs or larvae were found in the dried tubes, months or years after the attempted rearings had been concluded.

tube examined some years later (long after all the tubes had been allowed to dry out), larvae were also found, dead and dry. Although living eggs were not observed in these tubes, egg remnants were eventually found when the opportunity to examine the tubes in detail with a microscope occurred. Two female adults, on being slide-mounted, were also found to contain eggs, although no eggs or larvae were recovered from their tubes. The details of these experimental animals are summarized in Table 3.

Taxonomic Placing of Odontacarus swani *n. sp.*

The larva of this species is distinguished from others of the genus by the following combination of characters: (1) palpal tibial claw three-pronged, (2) galeala nude, and (3) about 57 dorsal body setae present, (4) two mastitibialae III present, (5) one mastitarsala III present, palpal genuala (PaScGe) and the two palpal tibialae (PaScTi1 and PaScTi3) almost nude, with only faint indications of barbs, cheliceral fangs with a row of 3-4 dorsal and 4-5 ventral denticles.

Characters (1), (2) and (3) alone are sufficient to distinguish this species from all others of the Australasian to South-East Asian region (subgenus *Leogonius*).

The diagnostic characters of the adult have been given above.

Nomenclature

This species is dedicated to Duncan Campbell Swan (28.xi.1907-26.xii.1960), entomologist, who made field observations on the distribution of chigger mites in South Australia (see Southcott, 1982).

Classification of the Larvae of the Australian, New Guinean and South-East Asian Species of Odontacarus

About 20 species of *Odontacarus* have been described from Australia and New Guinea (including West Irian and Papua New Guinea). A single further species, *O. audyi* (Radford, 1946) has been described from South-East Asia, one, *O. gymnodactyli* (Ewing, 1925) (1925b) from India, and one, *O. lygosomae* (Dumbleton, 1947), from New Zealand. Since only limited keys to the classification of these species have been offered since Womersley's (1944, 1945) papers, an attempt to key the species of this region is offered here.

The most detailed studies of recent years for this region have been done by Goff and Loomis (see references), who unfortunately deal only with the species from New Guinea, and incidentally with a few north Queensland species, where these occur also in New Guinea.

In attempting to classify the larvae here allotted to *O. swani* n. sp., as well as various other species from northern Queensland and New Guinea, I have experienced difficulty in using one of the main characters used by Goff (1979a, b) in classification, this being deciding on the number of setae on the dorsum of the abdomen in the "first post-humeral row", i.e. the row of setae immediately behind the dorsal scutum, but excluding the two (or four) long "humeral" or "scapular" setae. These remarks apply not only to the specimens of *O. swani* described here, but also members of the type series of *O. athertonensis* (Womersley, 1945), and of *O. mccullochi* (Wom., 1944), which were used by Goff (1979a) in drawing up his key to the species which occur in New Guinea.

For this reason, it has been decided not to use the number of the setae in this row as a key character. It should also be noted that students of the larvae of the Trombidioidea and Erythraeoidea usually experience difficulty in deciding which setae to allot to different rows, as the arrangement is commonly irregular, and the allotment of the setae is largely a matter of guesswork. On the other hand, the total number of dorsal or ventral idiosomal setae appears to be free from these defects, even if the counting of them is at times tedious.

The following key to the larvae of *Odontacarus* for this region is therefore proposed, based to a large extent upon already published descriptions, but supplemented with some new data.

KEY TO THE LARVAE OF *ODONTACARUS* (SUBGENUS *LEOGONIUS*) OF AUSTRALIA, NEW GUINEA AND SOUTH-EAST ASIA

1. Palpal tibial claw with more than three prongs .. 2
   Palpal tibial claws with three prongs 6

2. Palpal tibial claw with seven prongs ..... *O. riennae* Goff, 1979
Palpal tibial claw with four prongs 3
3. AL setae longer than PL ..... *O. nadchatrami* Goff, 1979
AL setae shorter than PL 4
4. Mastitibialae III absent. Two mastitarsalae III present. Dorsal idiosomal setae about 110 ..... *O. mitchelli* Goff, 1981
One or more mastitibialae III present 5
5. One mastitibiala III present. Dorsal idiosomal setae about 230 ..... *O. unisetosus* Goff, 1979
Two mastitibialae III present to tibial III 6
6. Galeala nude. Palpal setal formula B/B/BNN/So + 7B. About 120 dorsal idiosomal setae present ..... *O. trisetosus* Goff, 1979
Galeala barbed 7
7. Dorsal idiosomal setae number about 54. Ventral idiosomal setae about 78. Palpal setal formula B/B/BBB/So + 7B. Cheliceral denticles 4-5d/4-7v ..... *O. ziegleri* Goff, 1979
Dorsal idiosomal setae number about 52-90. Ventral idiosomal setae number about 46-56. Palpal setal formula B/B/Bbb/So + 7B. Cheliceral denticles 7d/6-8v. ..... *O. audyi* (Radford, 1946)
(Occasional specimens of *O. audyi* have only three palpal tibial prongs (see Nadchatram, 1963).)
8. Mastitibialae III lacking 9
Mastitibialae III present 11
9. Mastitarsalae III lacking. About 42 dorsal idiosomal setae present. Cheliceral denticles 3-4d/3-4v. AM seta short and thickened, reaching about 2/3 across to the AL seta base (Fig. 7A, B) ..... *O. southcotti* (Womersley, 1944)
Mastitarsalae III present 10
10. Cheliceral denticles 4-5d/1v (Fig. 7C). DS to 22 μm long ..... *O. langani* (Southcott, 1957)
Cheliceral denticles 3-4d/4-5d (Fig. 7D). DS 29-32 μm long ..... *O. mathewi* (Southcott, 1957)
11. Tibia III with three mastitibialae. Palpal setal formula B/B/BBB/So + 7B. Cheliceral denticles 3d/3v. One mastitarsala III present ..... *O. mccullochi* (Womersley, 1944)
Tibia III with two mastitibialae 12
12. About 30 opisthosomal ventral setae present ..... *O. adelaideae* (Womersley, 1944)
More than 30 opisthosomal ventral setae present 13
13. PL/AL less than 1.20 ..... *O. nova-guinea* Womersley, 1944) and *O. longipes* (Womersley, 1945)
PL/AL greater than 1.20 14
14. Over 75 dorsal idiosomal setae present ..... *O. australiensis* (Hirst, 1925) and *O. hirsti* (Womersley, 1944)
Less than 70 dorsal idiosomal setae present 15
15. More than 58 ventral opisthosomal setae present. Cheliceral denticles 3d/4v (Fig. 7E) ..... *O. cooki* (Southcott, 1957)
Less than 58 ventral opisthosomal setae present . 16
16. PSB/SB <1.00[1]. PW 87 μm ± 1 μm (Womersley, 1945) ..... *O. barrinensis* (Womersley, 1945)
PSB/SB ≥1.00[1]. PW mostly less than 85 μm 17
17. PL/AL > 1.3. Ventral opisthosomal setae 48-54 in number. Palpal setal formula B/B/BBB/So + 7B. ..... *O. athertonensis* (Womersley, 1945)
PL/AL < 1.3. Ventral opisthosomal setae in range of 35-45 in number 18

[1] For *O. barrinensis* and *O. echidnus* this statistic is based on Womersley's (1945) Figs. 5F and 5D respectively.

18. AW 54-61. PW/(A-P) < 2.75[2] ..... *O. echidnus* (Womersley, 1945)
AW 65-73. PW/(A-P) ≥ 2.75. Palpal setal formula B(b)/N(?b)/BNN/So + 7(B or N). Galeala nude .... *O. swani* n. sp.

[2] From Womersley (1945).

The following two species have been omitted from the above key:

(1) *Odontacarus gymnodactyli* (Ewing, 1925) (1925b), described from India. This species was doubtfully referred to *Acomatacarus (Acomatacarus)* by Wharton and Fuller (1952, p. 98), who list the previous synonymy. The descriptive details are insufficient to place this species in the above key.

(2) *Odontacarus lygosomae* (Dumbleton, 1947), from New Zealand. The descriptive details are insufficient for the placing of this species in the above key. Nevertheless it is quite a distinct species, with a wide dorsal scutum, and flattened, broad, lanceolate scutalae and dorsal idiosomal setae, the latter numbering about 100.

Analysis of Morphometric Data of O. swani *Larvae*

In previous papers I have attempted to determine correlations and other relationships between variates that are used by taxonomists for classificatory purposes, to see if they may be a useful basis for more general studies such as whether the mechanisms controlling size are interrelated in some way, e.g. genetic. Southcott (1966, pp. 736-738) reported on the correlation of the standard data for the erythraeoid larval mite, *Charletonia swaziana* (Lawrence, 1940). In a later paper (Southcott, 1986a) a correlation study by principal component analysis (Hotelling, 1933) was presented for both scutal and leg variates for a trombidioid larval mite, *Trombella alpha* Southcott. In the present paper a series of larval *O. swani* is similarly analysed. Some of the same remarks made about utilizing the data of Southcott (1986a) apply also to the present paper. In attempting to elucidate relationships we have here a group of larvae reared from conspecific adults, collected over a few square metres of soil, near the surface, on a single day. Additionally, the batches of larvae were reared with damp soil in sealed tubes in my baggage, so that all the larvae of each batch may be said to have experienced at least similar conditions in their life-spans. Such conditions could therefore possibly eliminate sources of variation from dissimilar conditions of rearing.

In making statistical analyses, as was done with the study of the larvae of *Trombella alpha*, we may restrict the data for the dorsal setae to a single variate, in view of the partial redundancy in using the variates DS, mid-DS and PDS. We may also omit the data for Sens, since these sensillary setae are slender, flexible and difficult to measure accurately; also these setae are commonly absent in microscopic mounts, whether from the

TABLE 4. CORRELATION MATRIX FOR VARIATES OF LARVAE OF *ODONTACARUS SWANI*, ON 6D, F.

											$r=.05^{*}$	$\lvert r\rvert \geqslant$ .7067	
											.01**		.8343
											.001***		.9249
AW	1	1.0000											
PW	2	0.5398	1.0000										
SB	3	-0.0196	0.4631	1.0000									
ASB	4	0.7239*	0.7837*	0.0073	1.0000								
PSB	5	0.1575	-0.4072	-0.0605	-0.4419	1.0000							
L	6	0.7776*	0.2517	-0.0556	0.4006	0.6449	1.0000						
LA	7	0.1486	0.1448	-0.3346	0.4734	-0.7780*	-0.3913	1.0000					
LB	8	0.5494	0.1402	0.0869	0.1284	0.8068*	0.9335**	-0.6953	1.0000				
LN	9	0.4843	0.7155*	0.1347	0.8698**	-0.4914	0.2391	0.3965	0.0323	1.0000			
W	10	0.7987*	0.3830	-0.0172	0.6397	0.1270	0.6746	0.0747	0.4978	0.6750	1.0000		
W-P	11	0.4747	-0.2294	-0.3721	0.3081	0.1496	0.4153	0.3130	0.2024	0.3620	0.7228*	1.0000	
AM	12	-0.1337	0.0183	0.1992	-0.4155	0.6304*	0.2899	-0.8522**	0.5585	-0.4757	-0.3079	-0.6306	1.0000
AL	13	0.6550	0.1347	0.1693	0.5271	0.1631	0.6156	0.0884	0.4463	0.5013	0.7503*	0.7681*	-0.4424
PL	14	0.5140	0.6407	0.2390	0.6859	-0.4335	0.0905	0.4734	-0.1157	0.8478*	0.6933	0.3853	-0.5403
AMB	15	0.4246	0.5238	0.6472	0.3663	-0.3055	0.0000	0.1787	-0.0696	0.2649	0.3301	0.0000	-0.2660
MDS	16	0.3544	0.5057	-0.3326	0.5924	-0.1939	0.3066	0.2174	0.1547	0.6633	0.3973	0.1157	-0.0169
PDS	17	0.3004	0.7767*	0.4089	0.3892	-0.4036	-0.0907	0.1856	-0.1353	0.4201	0.1632	-0.3796	0.0891
G1	18	0.6200	0.8705**	0.2934	0.8002*	-0.1677	0.5104	0.0755	0.3692	0.6446	0.3520	-0.0993	0.0859
T1	19	0.2341	0.0855	0.7242*	-0.1776	0.3419	0.1979	-0.3966	0.3091	-0.1153	0.2909	0.0778	0.1250
G2	20	0.2967	0.4184	0.0095	0.5002	-0.0530	0.3669	-0.2055	0.3666	0.3747	0.3692	-0.0254	0.1224
T2	21	0.0939	-0.2306	-0.4529	0.3605	-0.2673	0.0341	0.4788	-0.1599	0.4056	0.3854	0.7455*	-0.7575*
G3	22	0.4627	0.6614	0.2436	0.4519	-0.0383	0.3453	-0.2224	0.3568	0.5041	0.5980	-0.0727	0.2259
T3	23	0.6634	0.5465	0.5075	0.5950	-0.0636	0.4420	0.0951	0.3081	0.6876	0.8114*	0.5066	-0.3565
		1	2	3	4	5	6	7	8	9	10	11	12
AL	13	1.0000											
PL	14	0.4238	1.0000										
AMB	15	0.3907	0.4924	1.0000									
MDS	16	-0.0258	0.4949	-0.3527	1.0000								
PDS	17	-0.2258	0.6434	0.4468	0.4443	1.0000							
G1	18	0.3415	0.4162	0.2562	0.5529	0.4875	1.0000						
T1	19	0.3953	0.1928	0.6963	-0.5525	0.1633	-0.0803	1.0000					
G2	20	0.2372	0.0378	0.2045	0.1659	-0.0594	0.3719	-0.0890	1.0000				
T2	21	0.5458	0.1834	-0.1021	0.0648	-0.5609	-0.1255	-0.3198	0.2817	1.0000			
G3	22	0.0786	0.5406	0.3904	0.4337	0.6148	0.3750	0.2548	0.5987	-0.2092	1.0000		
T3	23	0.8071	0.7361*	0.6722	0.1185	0.3354	0.4534	0.6046	0.1795	0.1944	0.4701	1.0000	
		13	14	15	16	17	18	19	20	21	22	23	

Note: In the list of variates, for G read Ge, and for T read Ti, thus G2 means GeII, etc. (This applies also in subsequent correlation tables of these variables).

capture, mounting or preservation procedures themselves or possibly earlier traumas of life. Omitting also PW/LB, which is a statistic derived from two of the listed variates, we may therefore construct a 8×23 table of variates from these data.

A correlation matrix of 23×23 values (including L, which is the sum of LA + LB, or ASB + PSB) was then calculated. There are only 21 independent measures in the table of r, on 6 degrees of freedom (Table 4).

The table of the correlation matrix shows a total of 25 significant correlations (at P=.05 or at greater significance).

From this we may calculate a principal component analysis (Table 5). As there were only eight specimens in the series, it was considered the principal component analysis should be restricted to only two (first and second) components.

Table 5 for the principal components for the variates selected for study in *O. swani* shows that the first principal components includes all 23 variates with the exception of SB, PSB, LA, LB, A-P, AM, PDS, Til, Gell and TiII, indicating that this component may represent a size variable affecting the majority of the variates; and the second principal component includes PSB, L, LB, and AM (also LA and TiII, of opposite sign of the direction cosines), thus indicating that these measures are correlated, and that after allowing for size, where one group is relatively large, the other is relatively small.

Further Studies on the Relationships of Variables Used in Classification of Trombiculid Mite Larvae

Statistical analyses of chitinized parts of various trombidioid, erythraeoid and other mites have been increasingly used as an aid to classification. My use of correlation analyses to determine the interrelationships of these variates has been outlined above. In my 1986 (1986a) study I showed that there is a correlation between a variate dependent upon a body character (scutum) and of a leg character, in some cases. Above it was found that in *O. swani* larvae both principal components (first and second) include both scutal and leg dimension variates, these being positively correlated in the case of the first, and both positively and negatively (for the different variates) in the case of the second.

In order to decide whether such interrelationships are an expression of some more general phenomenon or phenomena, it was decided to do similar studies on some other species of related trombiculid mites. According to keys in existence before the present study was commenced, it was thought that the larvae described above as *Odontacarus swani* were classified close to *O. athertonensis* and *O. mccullochi*, and initially were classified as *O. athertonensis*. Both of these species are included in the same couplet in the key of Goff (1979a, p. 154). These two species of larvae were therefore selected as being suitable for similar correlation studies, with the additional hope that if difficulties in classification were to appear, the correlation study might provide some guidance as to the relationships between these species. Accordingly careful measurements were made on the available series of these two species also. Ultimately, with further study, it was found that the larvae described here as *O. swani* differed in several characters from both *O. athertonensis* and *O. mccullochi*, so that only *O. athertonensis* and *O. swani* appear close together in the key above.

In the case of *O. athertonensis* a long series of larvae was available (28 specimens), and in the case of *O. mccullochi*, 10 specimens. These were measured for the same structures as in *O. swani*. Nevertheless, it is clearly as valuable to test for species widely separated from each other as for closely related species, in a search for such interrelationships.

Odontacarus athertonensis (Womersley)

Synonymy

Acomatacarus athertonensis Womersley, 1945, p. 104; Taylor, 1946, p. 226; Fuller, 1952, p. 230; Gunther, 1952, p. 40; Wharton and Fuller, 1952, p. 97; Audy, 1954, p. 164.

Odontacarus athertonensis Goff, 1979a, p. 144.

Source of the Larvae of Odontacarus athertonensis *Used in the Present Study*

The larvae of *O. athertonensis* studied for the present paper came from the following sources:

(1) The type series of 19 larvae, identification numbers ACB732A-S, Wongabel, Q., October, 1944, R. N. McC[ulloch], also two further larvae, identification numbers ACB732T, U, with same locality, date and collector information; South Australian Museum collection. Specimen ACB732A slide is notated "Syntype"; specimens ACB732B-S are notated as

TABLE 5. PRINCIPAL COMPONENT ANALYSIS OF THE VARIATES OF *ODONTACARUS SWANI* LARVAE

	1	*2*
AW	−0.2846	0.1073
PW	−0.2688	0.0357
SB	−0.0810	0.1797
ASB	−0.3111	−0.1144
PSB	0.0774	0.3769
L	−0.1860	0.2875
LA	−0.0884	−0.4182
LB	−0.1108	0.3875
LN	−0.3032	−0.1458
W	−0.2984	0.0569
A-P	−0.1496	−0.1097
AM	0.1187	0.3843
AL	−0.2384	0.0396
PL	−0.2891	−0.1461
AMB	−0.1852	0.0307
MDS	−0.1713	−0.0782
PDS	−0.1625	0.0058
G1	−0.2475	0.0756
T1	−0.0745	0.2512
G2	−0.1476	0.0949
T2	−0.0850	−0.2692
G3	−0.2199	0.1564
T3	−0.3011	0.548

Paratypes; specimens ACB732T, U are without type notation.

Womersley stated (1944, p. 105) that the species was "described from 16 syntypes". Specimen ACB732A, which bears also a number N1981384, and was presumably the one examined by Goff (1979a), is hereby formally designated the lectotype.

(2) Six larvae, mounted individually on slides, identification numbers ACB733A-F, Mt. Jukes, Q[ueensland] [21°00'S, 148°57'E], 6.ix.1951, E. H. Derrick (South Australian Museum collection). These six slides were also examined by Goff (1979a), and bear the notations G192, G193, G197, G196, G206, G197 respectively, also numbers G1981385-G1981390, respectively. Each slide also bears the comment "Was marked paratype" (this marking has been removed). These slides were clearly never part of the type series. Specimen ACB733C is a poor mount, unsuitable for detailed measurement.

Omitting specimen ACB733C, three of the five larvae key directly to *O. athertonensis* by the key given above, while for two others (ACB733 E & F) *O. athertonensis* is the nearest fit, there being a mismatch in each of PL/AL=1.225. Further studies of these larvae have been presented elsewhere (Veitch and Southcott, 1984; Southcott, 1986b).

(3) ACB734, one larva, Lae Test Area, Papua New Guinea, 24.iv.1944, R. N. McCulloch (S.A. Mus.). The slide has the notation: *Leeuwenhoekia (Acomatacarus)* nr. *athertonensis* Wom. Lae Test Area. 24.4.44. R. N. McC. Det. H. Womersley. AW and PW Standard Data longer. AW=75.6, PW=84.0. (This is a poor mount, the dorsal scutum being damaged.)

By the key given above this specimen comes to caption 18, but then does not fit the criteria of either *O. echidnus* or *O. swani*. A further analysis of the statistical data of this specimen has been made elsewhere (Veitch and Southcott, 1984; Southcott, 1986b).

In response to my request for locality data, Dr. R. N. McCulloch has replied (pers. comm., 1983): "Lae test area was jungle just off the main road and where I did stopping-time tests [see McCulloch 1944, 1946, 1947] probably a mile towards the big air strip from 2/7 A. G. H." (2nd/7th Australian General Hospital).

(4) ACB735, one larva, Lae Scrub, 24.iii.44, A. S. D. (South Aust. Mus.). The slide is additionally notated: "*Leeuwenhoekia (Acomatacarus)* nr. *athertonensis* Wom. AW and PW Standard Data longer. AW=70.0, PW=84.0. Det. H. Womersley." This is another poor mount.

By the key above this specimen is not identifiable, owing to both legs III being damaged.

As no mite student or collector with the initials A. S. D. was known to me, I have written to Dr. R. N. McCulloch asking for further locality and other information. He has replied (pers. comm., 1983) "ASD means, I guess, Advanced Stores Depot and was on the old disused civilian air strip which was between the new [i.e. 1944] active air strip and 2/7 A. G. H.".

TABLE 6. MORPHOMETRIC DATA (μm) OF *ODONTACARUS ATHERTONENSIS* (WOMERSLEY) LARVAE

Character	*Lectotype ACB732A*	*Conspecificity Queried*		*Range for Type series*	*n*	*Mean*[1]	*S.D.*[1]
		ACB734	*ACB735*				
AW	71	79	85	61-71	21	65.90	2.700
PW	80	91	90	75-87	21	77.62	2.655
SB	25	31	27	22-30	21	25.10	1.413
ASB	47	55	54(52)[4]	47-56	21	53.00	2.490
PSB	35	34(31)[4]	28(36)[4]	25-35	21	28.90	2.719
L	82	89(86)[4]	82(88)[4]	76-87	21	81.90	3.113
LA	16	20(25)[4]	18	16-23	21	19.81	2.040
LB	66	69(61)[4]	64(70)[4]	55-67	21	62.10	2.897
LN	25	30	29	25-32	21	29.05	2.202
W	94	96	97	81-96	21	87.14	4.246
A-P	25	32	27	25-32	21	28.24	1.814
AM	37	39	37	35-42	21	38.38	2.459
AL	41	46	46	37-46	21	40.71	2.101
PL	55	58	66	50-58	21	55.24	1.700
AMB	13	15	11	10-13	21	11.43	1.028
Sens	50	—	45	45-55	7	—	—
PW/LB	1.21	1.32	1.41	1.17-1.45	21	—	—
DS	29-42	33-64	36-67	(29-35)-(42-56)	21	—	—
mid-DS	29-40	33-38	34-44	(29-35)-(35-42)	21	37.76[3]	2.385[3]
PDS	36-40	42-46	33-42(-51)[4]	(35-38)-(38-46)	21	41.57[3]	1.964[3]
GeI	45	45	56	42-49	21	45.76	1.670
TiI	60	55	67	53-60	20	55.19	1.662
GeII	40	37	51	36-42	21	39.19	1.662
TiII	47	42	56	41-49	21	45.43	1.886
GeIII	49	42(44)[4]	56(58)[4]	44-50	21	45.71	1.875
TiIII	65	57	69(75)[4]	57-65	21	59.86	2.197

[1] The mean and the s.d. are calculated for the type series only with n = 21 (see text).
[2] In subsequent calculations of correlation the three missing values indicated by (a), (b) and (c) were replaced as follows: (a) AL for ACB732B: 41, (b) AM for ACB732S: 35, (c) TiI for ACB732B: 53, after a study of the data. This refers to the table of variates for the type series held on file in the South Australian Museum.
[3] Figures calculated from the maximal values only of that variate.
[4] Figures in brackets are a set of variant estimates made subsequently and which differed by 2 μm or more from the earlier ones, and used in calculations presented in Veitch and Southcott (1984) as a check on the reliability of analytical procedures. The specimens were the most separated from the others using the variables selected. Specimens ACB734 and ACB735 were poor mounts, presenting difficulties in microscopic measurement.

TABLE 7. CORRELATION MATRIX FOR VARIATES OF *ODONTACARUS ATHERTONENSIS* LARVAE, ON 19 D. F.

P=.05* |r| ≥ .4329
.01** .5487
.001*** .6652

AW	1	1.0000											
PW	2	0.5248*	1.0000										
SB	3	0.5529**	0.7437***	1.0000									
AS8	4	-0.4834*	-0.0832	0.0133	1.0000								
PS8	5	0.2371	0.0709	0.0266	-0.2881	1.0000							
L	6	-0.1796	-0.0046	0.0339	0.5483*	0.6429**	1.0000						
LA	7	-0.3575	-0.0325	0.1033	0.7874***	0.2288	0.4300	1.0000					
LB	8	0.0588	0.0180	-0.0364	0.0347	-0.8520***	-0.7718***	-0.2422	1.0000				
LN	9	-0.2095	0.0974	0.1936	0.7752***	-0.3083	0.3509	0.7813***	-0.1732	1.0000			
W	10	0.6903***	0.6438**	0.5113*	-0.1561	0.4517*	0.2697	-0.0544	0.3281	0.0206	1.0000		
A-P	11	-0.2197	-0.2190	-0.3001	0.0886	-0.5731**	-0.4297	-0.0277	-0.4423*	-0.0531	-0.2448	1.0000	
AM	12	-0.0018	0.1076	0.2719	0.2940	-0.2187	0.0442	0.0451	0.0157	0.0057	-0.1012	0.3597	1.0000
AL	13	0.2153	0.0781	0.1033	-0.0669	-0.0488	-0.0961	-0.2816	0.0951	-0.2996	0.0945	0.3861	0.4576*
PL	14	0.1686	0.1651	0.2628	-0.2480	-0.1247	-0.3073	-0.0151	-0.3196	-0.0433	-0.0604	-0.2463	-0.1185
AM8	15	0.1415	0.1178	-0.1561	-0.1562	0.3373	0.1696	-0.0068	0.1871	-0.1641	0.4205	-0.0306	-0.2260
MOS	16	-0.0115	0.0086	-0.1457	-0.1515	0.0117	-0.1109	-0.1331	-0.0255	-0.1405	-0.1594	-0.0902	-0.1542
POS	17	0.0108	-0.0904	0.0481	0.1227	0.1886	0.2629	-0.0713	0.3327	0.1900	0.1216	-0.2927	-0.3372
G1	18	-0.0607	-0.0778	0.1281	0.1082	-0.1484	-0.0430	0.2061	-0.1914	0.1528	-0.2769	0.2177	0.3883
T1	19	0.3385	0.0059	-0.0871	-0.3142	0.4248	0.1197	-0.3427	0.3700	-0.1393	0.0810	-0.3309	-0.0920
G2	20	0.1714	0.0059	0.0719	-0.2175	0.4690*	0.2356	-0.3575	0.5050*	-0.4125	-0.1032	-0.1319	0.2750
T2	21	-0.0309	0.0442	0.0200	-0.1704	0.5447*	0.3394	0.0613	0.3216	-0.2099	0.1668	-0.3675	-0.2526
G3	22	0.3796	-0.0632	0.0277	-0.5677**	0.4261	-0.0820	-0.4202	0.2078	-0.4690*	0.0619	-0.5524**	-0.3765
T3	23	0.3347	-0.0869	-0.1009	-0.5392*	0.4914*	-0.0021	-0.2518	0.1751	-0.3396	0.0934	-0.5430*	-0.3780

		1	2	3	4	5	6	7	8	9	10	11	12

AL	13	1.0000											
PL	14	0.1320	1.0000										
AM8	15	-0.0099	-0.0899	1.0000									
MOS	16	0.0755	0.0886	0.1252	1.0000								
POS	17	-0.2856	-0.3572	0.0460	0.0305	1.0000							
G1	18	0.1791	-0.1551	-0.1123	-0.0902	-0.2155	1.0000						
T1	19	0.0736	-0.2823	0.1839	0.3525	0.1488	0.3233	1.0000					
G2	20	0.1739	-0.1938	-0.0502	0.0625	0.0569	0.3233	0.4388*	1.0000				
T2	21	-0.2199	0.1381	0.2873	0.0572	0.0116	0.0023	0.0365	0.1641	1.0000			
G3	22	-0.3137	0.0381	0.0926	0.1629	0.2774	0.0411	0.4356*	0.3714	0.4465*	1.0000		
T3	23	-0.3558	0.1568	0.4047	0.2317	0.1125	-0.1732	0.5007*	0.2543	0.3413	0.6693***	1.0000	

		13	14	15	16	17	18	19	20	21	22	23

A further statistical study of the data of this specimen has been made elsewhere (Veitch and Southcott, 1984; Southcott, 1986b).

(5) ACB736, one larva, collection data as for ACB734. The slide bears the notation: "*Leeuwenhoekia (Acomatacarus)* nr. *athertonensis* Wom. Lae Test Area. 24.4.44. R. N. McC. AW and PW Standard Data longer. AW=68.6, PW=84.0. Det. H. Womersley."

Remeasuring gives AW about 65, PW about 75. From obscurity in the mount the specimen is not identifiable by the foregoing key, various key characters not being visible. (The data of this specimen have been omitted from the table given below (Table 4), as too many values are unavailable for it to be capable of being included in a correlation analysis.)

These three are the only specimens in the South Australian Museum collection placed as or near *O. athertonensis*, from Papua New Guinea. Although Goff (1979a, p. 146) states that the three specimens examined were from "Morobe Distr[.], Lae, 24.iv.1944, collected in scrub", only two slides bear the date 24.iv.1944, and the term "scrub" occurs on only one slide; none of these slides carry any loan number designations, apart from that implied by my identification numbers.

Data

The measurements of the standard data and other variates selected for study are shown in Table 6.

Results of the Correlation Analysis of the Variates of Odontacarus athertonensis *Larvae*

In Table 6 the means and standard deviations of the variates have been calculated from the type series only (ACB732A-U). The reason for this is that a preliminary discriminant analysis of the data given indicate that the specimens previously considered as conspecific, as well as those under the heading "Conspecificity queried" differ significantly in various statistical measures from the type series. This subject will be analysed further in another paper.* Accordingly, correlation analyses here will be confined to the data of the type series.

Proceeding as before, a correlation matrix of 23×23 values is calculated; this is shown in Table 7.

There are 32 correlations between variates shown in Table 7 at the 5% (or more significant) levels of probability. These are marked in the table by asterisks, as shown.

Examining the principal components as before, we may select the first and second principal components (in view of the sample size of 21 specimens). These are shown in Table 8.

From Table 8 we see that there are two significant groups of correlations. Component 1, of AW, PSB, LB, Til, GeII, TiII, GeIII, TiIII, together with (of opposite sign) ASB, LA, LN and A-P. This component thus represents a mixture of size and shape variables. Component 2, of ASB, PSB, L, LA, LB, LN and PDS, and (of opposite sign) A-P, which is thus seen to include mainly variables based upon the dorsal scutum. This component again is a mixture of size and shape variables.

TABLE 8. PRINCIPAL COMPONENT ANALYSIS OF THE VARIATES OF *ODONTACARUS ATHERTONENSIS* LARVAE

	1	*2*
AW	−0.2232	0.1410
PW	−0.0750	−0.0299
SB	−0.0399	0.0587
ASB	0.2704	−0.3856
PSB	−0.3569	−0.2042
L	−0.0954	0.4868
LA	0.2266	−0.3494
LB	−0.2621	−0.2770
LN	0.2255	−0.3471
W	−0.1864	0.1381
A-P	0.2743	0.2177
AM	0.1562	0.0371
AL	0.0486	0.1865
PL	0.0007	0.1760
AMB	−0.1648	−0.0630
MDS	−0.0869	0.1064
PDS	−0.1153	−0.2161
G1	0.0827	0.0341
T1	−0.2558	0.0222
G2	−0.2074	0.0255
T2	−0.2151	−0.1362
G3	−0.3325	0.0961
T3	−0.3248	0.0585

Odontacarus mccullochi (Womersley)

Synonymy

Leeuwenhoekia mccullochi Womersley, 1944, p. 108.
Acomatacarus mccullochi Womersley, 1945, p. 111. Taylor, 1946, p. 226. Gunther, 1952, p. 40.
Acomatacarus (Acomatacarus) mccullochi Wharton and Fuller, 1952, p. 99. Audy, 1954, p. 164
Odontacarus (Leogonius) mccullochi Goff, 1979a, pp. 147, 154.

Material Examined

(All specimens in South Australian Museum collection)

QUEENSLAND

Trinity Beach Area [Trinity Bay] 10.vii.1943, R. N. McC[ulloch], on boots, edge of scrub, four specimens, identification numbers ACB752A-D, A labelled Type, B-D Paratypes.

Trinity Beach, Cairns, Q[ld.], edge of scrub, 8.vii.1943, name of collector not stated, identification numbers ACB753A-D. (These slides are labelled Paratypes, although according to Womersley's account (1944, p. 109) they were not mentioned in the original description.)

Emerald, C[entral] Q[ueensland], Nov. 1948, ex *Pomatostomus temporalis*, H. W[omersley], two specimens, identification numbers ACB754A, B.

Data

The measurements of the standard data and other variates selected for study are shown in Table 9.

* Note added in proof: This has now been done; see Veitch and Southcott (1984).

TABLE 9. MORPHOMETRIC DATE (μm) FOR *ODONTACARUS MCCULLOCHI* LARVAE

Character	Type (ACB752A)	Range	n	Mean	S.D.
AW	62	56-66	10	62.50	3.206
PW	77	74-83	10	78.20	3.084
SB	24	23-27	10	24.20	1.229
ASB	50	46-59	10	51.00	3.916
PSB	24	24-28	10	26.10	1.370
L	74	73-87	10	77.10	4.358
LA	18	15-21	10	17.70	2.163
LB	56	56-66	10	59.20	3.360
LN	27	22-31	10	26.30	4.138
W	86	78-93	10	86.80	4.492
A-P	32	24-35	10	30.90	3.315
AM	33	33-40	9	35.50	2.369
AL	41	34-41	10	37.80	2.394
PL	53	47-58	10	52.70	3.621
AMB	11	9-14	10	10.90	1.287
Sens	56	46-56	—	—	—
PW/LB	1.38	1.20-1.38	—	—	—
DS	31-56	(25-31)-(47-62)	—	—	—
mid-DS	31-36	(25-31)-(31-36)	10	34.70[1]	1.567[1]
PDS	36-40	(31-36)-(33-40)	10	38.70[1]	2.406[1]
Gel	54	46-54	9	49.70	2.584
Til	56	55-62	9	57.70	2.751
GeII	38	38-46	10	42.20	2.741
TiII	46	43-52	10	47.20	2.741
GeIII	49	45-54	10	48.00	2.867
TiIII	62	57-63	10	61.00	2.211

1. Figures for the maximum values of the variate.

Analysis of Morphometric Data for Odontacarus mccullochi *Larvae*

The data in Table 9 were submitted to the previously described analysis, the variate Sens being omitted for the reasons as before. Likewise the variates involving the dorsal idiosomal setae were restricted to the maximum values of the mid-DS and PDS variates.

Proceeding as before we thus have a 23 × 23 table on 8 degrees of freedom (Table 10).

Table 10 shows 28 significant correlations between the variables, at the 5% or greater level of significance.

From these data we may perform a principal component analysis, as before. This is shown in Table 11.

From Table 11 it can be seen that there are two significant groups of correlations. Component 1, of AW, PW, SB, ASB, L, LA, BL, LN, W, A-P, AMB, Gel, Til and TiII, i.e. indicating largely that this is a correlation induced by size factors. Component 2, of AW, Til, TiII, GeIII and TiIII, and (of opposite sign) LA, LN, A-P, AL, AMB, MDS and PDS; it is thus a mixture of correlations of opposite signs, involving variables derived from scutum, body setae and leg dimensions.

Conclusions on Correlations Between Measurements of Chitinized Idiosomal and Leg Parts in Three Species of Larval Trombidioid Mites

My earlier study on *Trombella alpha* (Southcott, 1986a) and the present study of three species of trombiculids have defined in each species the first two (or three) principal components in a comparable series of variates from specified chitinized parts of the body and limbs of these mites. The findings are set out in Table 12.

It is apparent from the preceding analysis and Table 12 that the correlation patterns are different in each species of mite studied, for the variates that have been selected for study. For the first principal component, there appears to be a greater similarity between the patterns between *O. mccullochi* and *O. swani*, than between either of these species with *O. athertonensis*. The patterns of the first principal component in these three species of *Odontacarus* resemble each other more than they do that of *Trombella alpha*.

This result suggests that all of these measurements may be necessary to separate species of *Odontacarus* and, by an extension of this concept, species in other genera of mites.

There is thus not a compact set of correlations manifested in these data. This is due in part to the small sizes of the samples studied, although other causes of these variations and comparative paucity of correlations could be suggested, particularly nutritional or other environmental factors.

Odontacarus southcotti (Womersley)
(Fig. 7A, B)

Synonymy

Leeuwenhoekia southcotti Womersley, 1944, p. 109. Taylor, 1946, p. 232.

Acomatacarus southcotti Womersley, 1945, p. 111. Taylor, 1946, p. 226. Gunther, 1952, p. 40.

Acomatacarus (Acomatacarus) southcotti Wharton and Fuller, 1952, p. 100; Audy, 1954, p. 164.

Material Examined

NORTHERN TERRITORY: Type series ACB169A1-7, South Australian Museum collection, Adelaide River, 15.vi.1943, on skink. (These are the only specimens in the S.A.M. collection; originally I had submitted 10 specimens, on two slides, labelled ACB169A (8 specimens) and ACB169B (2 specimens).

Remarks on Collection Data

On 15.vi.1943 I collected 10 or more red larval mites from the external auditory meati of a small skink, specimen R45 (my number), in the Adelaide River area, about 12 km (8 miles) east of the 57 mile point (i.e. 57 miles (91 km) southwards along the main road from Darwin; this being the current military nomenclature). This is about lat. 13°06'S, long. 131°14'E. There were 5 or more larval mites in each ear of the skink; but none in the axillae or elsewhere on the external surface of the skink. The skink was later identified as *Leiolepisma ?pectoralis* by Mr F. J. Mitchell, South Australian Museum, but not kept. Another specimen caught at the same time and place (my R46) was identified by Mr Mitchell as *L. pectoralis*, and is preserved in the South Australian Museum collection as R2703.

These notes supersede the collection data given by Womersley (1944, p. 110), which are partly wrong.

TABLE 10. CORRELATION MATRIX FOR VARIATES OF *ODONTACARUS MCCULLOCHI* LARVAE, ON 8 D. F.

P=.05* $|r| \geq$ .6319
.01** .7646
.001*** .8721

AW	1	1.0000										
PW	2	0.6968*	1.0000									
S8	3	0.3947	0.2521	1.0000								
AS8	4	0.3717	0.5612	0.4386	1.0000							
PS8	5	-0.4679	-0.1367	-0.1451	0.1657	1.0000						
L	6	0.1869	0.4613	0.3485	0.9507***	0.4633	1.0000					
LA	7	0.2644	0.2599	0.5684	0.8397**	-0.1387	0.7109*	1.0000				
L8	8	0.1032	0.5211	0.0430	0.7770**	0.6468*	0.9016***	0.3608	1.0000			
LN	9	0.4024	0.5729	0.3344	0.8488**	-0.1372	0.7195*	0.8674**	0.5128	1.0000		
W	10	0.7638*	0.8935***	0.1489	0.6064	-0.3033	0.4496	0.3934	0.4594	0.6971*	1.0000	
A-P	11	0.1621	0.5673	0.2236	0.7447*	-0.1688	0.6161	0.7082*	0.4808	0.7823**	0.6328*	1.0000
AM	12	-0.6511*	-0.2129	-0.4961	-0.3953	0.3936	-0.2314	-0.4663	-0.0140	-0.3231	-0.3759	-0.1061
AL	13	-0.2171	0.0211	-0.4379	0.0830	-0.3996	-0.0511	0.2017	-0.0912	0.2484	0.1405	0.5711
PL	14	0.3733	0.3084	-0.3744	-0.3370	-0.4703	-0.4507	-0.3547	-0.2649	-0.0242	0.4782	-0.0463
AMB	15	0.1481	0.3136	0.5760	0.5293	-0.2458	0.3983	0.7466*	0.1336	0.6560*	0.3806	0.7268*
MOS	16	0.0111	0.4276	-0.2538	0.3622	-0.2432	0.2490	0.2656	0.3081	0.4995	0.5904	0.7850**
POS	17	-0.3673	-0.3953	-0.0526	0.3066	-0.0910	0.2469	0.6213	-0.0055	0.3980	-0.1398	0.4555
G1	18	0.6237	0.3569	0.5457	0.3294	-0.4613	0.1510	0.3400	-0.0307	0.2691	0.3389	0.0999
T1	19	0.5229	0.6496*	0.5126	0.5261	0.2152	0.5404	0.1886	0.5723	0.3323	0.5162	0.1791
G2	20	0.1012	0.1656	0.3166	0.2485	0.3195	0.3238	0.1425	0.2848	0.2138	0.0397	-0.0465
T2	21	0.4932	0.6652*	0.5475	0.4970	0.1420	0.4912	0.2549	0.4778	0.4372	0.4729	0.1737
G3	22	0.6043	0.6911*	0.2207	0.1583	-0.2262	0.0711	-0.1433	0.1615	-0.0458	0.4744	0.1636
T3	23	0.5800	0.2281	0.5723	0.3208	-0.3667	0.1730	0.3253	-0.0449	0.1978	0.2237	0.0455

		1	2	3	4	5	6	7	8	9	10	11	12
AM	12	-0.6511*	-0.2129	-0.4961	-0.3953	0.3936	-0.2314	-0.4663	-0.0140	-0.3231	-0.3759	-0.1061	1.0000
AL	13	-0.2171	0.0211	-0.4379	0.0830	-0.3996	-0.0511	0.2017	-0.0912	0.2484	0.1405	0.5711	0.1763
PL	14	0.3733	0.3084	-0.3744	-0.3370	-0.4703	-0.4507	-0.3547	-0.2649	-0.0242	0.4782	-0.0463	-0.1295
AMB	15	0.1481	0.3136	0.5760	0.5293	-0.2458	0.3983	0.7466*	0.1336	0.6560*	0.3806	0.7268*	-0.3463
MOS	16	0.0111	0.4276	-0.2538	0.3622	-0.2432	0.2490	0.2656	0.3081	0.4995	0.5904	0.7850**	0.1048
POS	17	-0.3673	-0.3953	-0.0526	0.3066	-0.0910	0.2469	0.6213	-0.0055	0.3980	-0.1398	0.4555	-0.0877
G1	18	0.6237	0.3569	0.5457	0.3294	-0.4613	0.1510	0.3400	-0.0307	0.2691	0.3389	0.0999	-0.8259**
T1	19	0.5229	0.6496*	0.5126	0.5261	0.2152	0.5404	0.1886	0.5723	0.3323	0.5162	0.1791	-0.2132
G2	20	0.1012	0.1656	0.3166	0.2485	0.3195	0.3238	0.1425	0.2848	0.2138	0.0397	-0.0465	0.3423
T2	21	0.4932	0.6652*	0.5475	0.4970	0.1420	0.4912	0.2549	0.4778	0.4372	0.4729	0.1737	-0.1883
G3	22	0.6043	0.6911*	0.2207	0.1583	-0.2262	0.0711	-0.1433	0.1615	-0.0458	0.4744	0.1636	-0.2617
T3	23	0.5800	0.2281	0.5723	0.3208	-0.3667	0.1730	0.3253	-0.0449	0.1978	0.2237	0.0455	-0.4031

		13	14	15	16	17	18	19	20	21	22	23
AL	13	1.0000										
PL	14	0.1025	1.0000									
AMB	15	0.2092	-0.0000	1.0000								
MOS	16	0.6633*	0.3525	0.3692	1.0000							
POS	17	0.5863	-0.2806	0.4917	0.2977	1.0000						
G1	18	-0.1365	0.0237	0.1905	-0.0796	-0.1948	1.0000					
T1	19	-0.5499	-0.1116	0.0220	0.0541	-0.5691	0.4080	1.0000				
G2	20	-0.4504	-0.4255	-0.1828	-0.1915	-0.2932	-0.1475	0.6131	1.0000			
T2	21	-0.5012	-0.1120	0.1008	-0.0103	-0.5459	0.4801	0.9226***	0.6302	1.0000		
G3	22	-0.0162	0.1391	-0.0602	0.0495	-0.5959	0.4948	0.4508	-0.0848	0.3817	1.0000	
T3	23	-0.2099	-0.3192	-0.0781	-0.1603	-0.2089	0.6028	0.5481	0.4951	0.4951	0.3855	1.0000

TABLE 11. PRINCIPAL COMPONENT ANALYSIS OF THE VARIATES OF *ODONTACARUS MCCULLOCHI* LARVAE

	1	2
AW	- 0.2326	0.1860
PW	- 0.2784	0.0693
SB	0.2094	0.1310
ASB	- 0.3164	- 0.1233
PSB	0.0359	0.0428
L	- 0.2730	- 0.0974
LA	- 0.2598	- 0.2159
LB	- 0.2155	- 0.0462
LN	- 0.2920	0.1979
W	- 0.2796	- 0.0299
A-P	- 0.2459	0.2958
AM	0.1781	0.0525
AL	0.0158	- 0.3645
PL	0.0307	0.0012
AMB	0.1930	0.2467
MDS	- 0.1259	0.2859
PDS	0.0017	0.4122
G1	- 0.1934	0.1564
T1	- 0.2514	0.2677
G2	- 0.1009	0.1977
T2	0.2511	0.2536
G3	- 0.1443	0.2099
T3	0.1735	0.2212

Additional Notes on Morphology

This species has a broad, shallow dorsal scutum, with short, rather thickened, AM setae, which reach about two-thirds of the way across to the AL seta bases. The cheliceral fang has 3-4 dorsal, and 3-4 ventral, denticles. These features are illustrated in Figs. 7A, B.

Odontacarus barrinensis (Womersley)

Synonymy

Acomatacarus barrinensis Womersley, 1945, p. 106. Taylor, 1946, p. 226. Gunther, 1952, pp. 41, 48.

Acomatacarus (Acomatacarus) barrinensis Wharton and Fuller, 1952, p. 98. Audy, 1954, p. 164 (with query).

Remarks on Collection Data

Womersley recorded (1945, p. 106) "Described from five syn-types collected free, from Lake Barrine, Queensland, 16 Nov. 1943 (R.V.S.), and a single specimen from man, Atherton Tableland, Queensland, 8 March 1944 (R.V.S.)".

Reference to my field and other notes shows that the first group ("five syn-types") were my serial ACB188, recorded originally by me as "ACB188...5 larval...Running over a log. Lake Barrine shores. Qld. 16.11.43."

With respect to the sixth specimen, stated to have been collected "from man, Atherton Tableland, 8 March 1944", this is my specimen ACB210A. This was the sole specimen of *Odontacarus* among a batch of mites which included many larval trombiculids (ACB210B, C, D, etc.) and two small (larval) ticks (ACC358, ACC359), collected parasitic on three soldiers at Gilbey Creek, near Wondecla, Atherton Tableland, Queensland (Map Ref. Herberton (1:63360) 392023), on 8 March 1944. The actual collector of the specimens was Cpl. E. Grinham, A Company, 2nd/7th Australian Field Ambulance, as I was away in another area at the time. The other larval trombiculid mites collected were later identified as *Eutrombicula hirsti* (Sambon, 1927).

Remarks on the Subgeneric Classification of the Larvae of Odontacarus *Ewing*

The genus *Odontacarus* (as well as a number of others of the family Trombiculidae) was revised and divided by Vercammen-Grandjean (1968). Definitions were submitted not in the usual terminology of acarological or even trombiculid description, but in Vercammen-Grandjean's own code. Such extensive use of codes in the descriptions and definitions of trombiculid mites has in fact been subject to criticism (see Brennan and Goff, 1977).

The following is an account of the revision of *Odontacarus* made by Vercammen-Grandjean (1968, pp. 120-121).

Definitions	Remarks and interpretation
Odontacarus Ewing, 1929 GT/*Trombicula dentata* Ewing, 1925	Type species, "genotype"
Leeuwenhoekiini of medium to large size.	A new tribe introduced by Vercammen-Grandjean on the same page (p. 120); on p. 119 he retained the family Leeuwenhoekiidae Womersley, 1945, and subfamily Leeuwenhoekiinae Womersley, 1944.
Ip = 700-1400	Ip = Index pedibus, the sum of the lengths of legs I, II and III. Despite its use by Vercammen-Grandjean, it must be considered of little diagnostic value; e.g. *Acomatacarus* (p. 122) is stated to have an Ip of 800-1020 (μm).

TABLE 12. ELEMENTS OF THE FIRST TWO (OR THREE) PRINCIPAL COMPONENTS OF A PRINCIPAL COMPONENT ANALYSIS OF COMPARABLE SERIES OF VARIABLES OF CHITINIZED IDIOSOMAL AND LEG STRUCTURES FOR THREE SPECIES OF LARVAL TROMBIDIOID MITES

Species	*Component 1*	*Component 2*	*Component 3*
Trombella alpha	ASB, L, A-P, TiIII	AW, PW, PSB, AM, GeI	DS, TI
Odontacarus athertonensis	AW, PSB, LB, TiI, GetI, TiII, GeIII, TiIII, -ASB, -LA, -LN, -(A-P)	ASB, PSB, L, LA, LB, PDS, -(A-P)	—
Odontacarus mccullochi	AW, PW, ASB, L, LA, LB, LN, W, A-P, AMB, GeI, TiI, TiII	AW, TiI, TiII, GeIII, TiIII, -LA, -LN, -(A-P), -AL, -AMB, -MBS, -PDS	—
Odontacarus swani	AW, PW, ASB, L, LN, W, AL, PL, AMB, MDS, GeI, GeIII, TiIII	PSB, L, LB, AM, -LA, -TiII	—

Note: ASB=ASBa in Southcott (1986a); PSB=ASBp likewise.

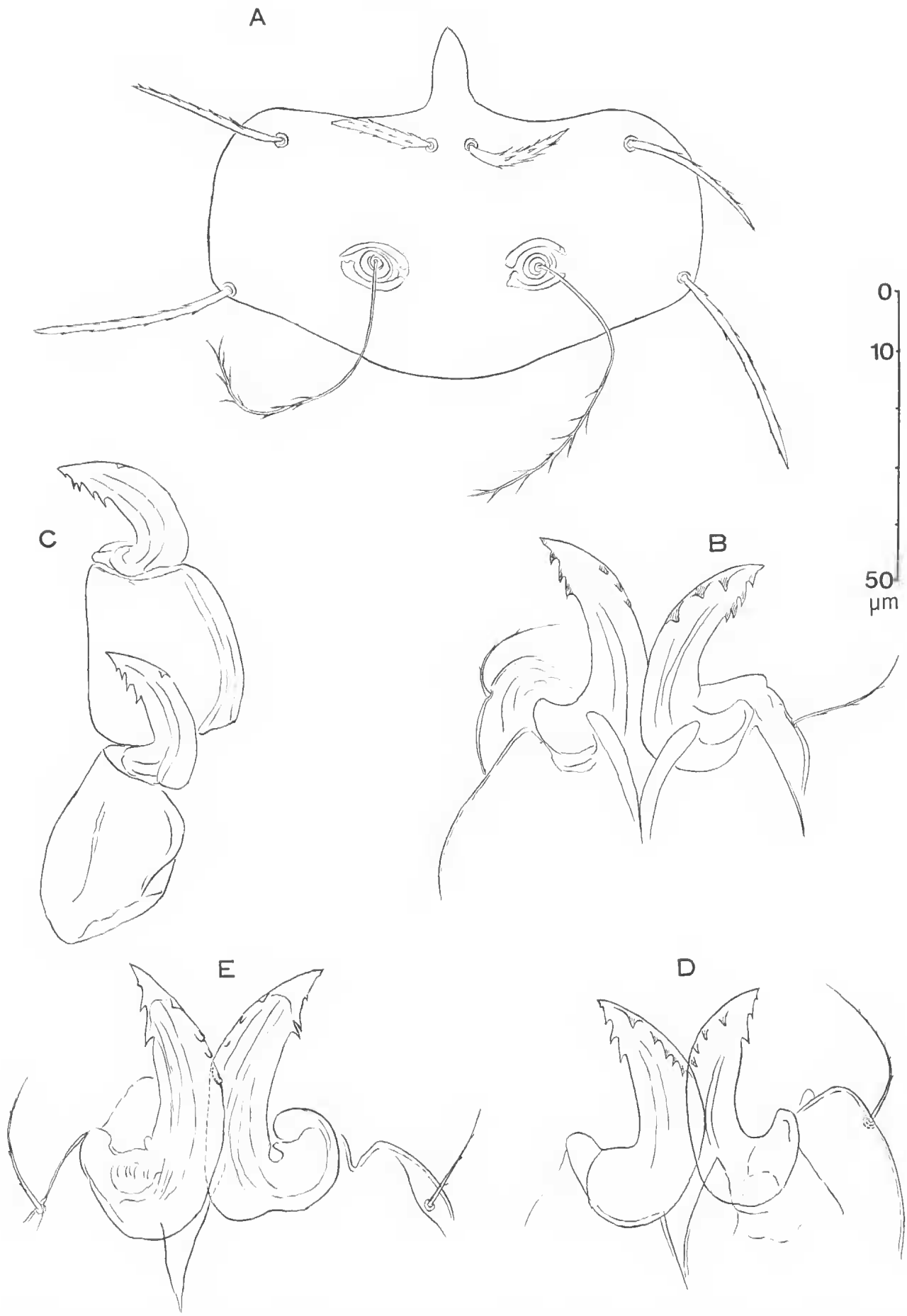

FIG. 7. A, B *Odontacarus southcotti* (Womersley), holotype larva; A Dorsal scutum, B Tip of mouthparts, dorsal view. C *O. langani* (Southcott), holotype larva, chelicerae, dislocated as on slide. D *O. mathewi* (Southcott), holotype larva, tip of mouthparts, dorsal view. E *O. cooki* (Southcott), holotype larva, tip of mouthparts, dorsal view. All to scale shown. (Note: in each case the distal half of the cheliceral fang is shown in transparency, so that the denticles on both the lateral and medial aspects are shown.)

Scutum roughly pentagonal with a nasus, 2 AM, 2 AL and 2 PL.	This means there are two anteromedian setae, two anterolaterals, and two posterolaterals to the scutum.
Eye lenses, 2p.	The term "2p" is not defined, but presumably means that two eyes are present on each side, each with a lens.
fT=7B	This is the code for the "palpotarsal pilous formula", meaning here that there are seven branched setae (plus a solenoidala, stated to be invariably present) on the palpal tarsus.
and palpotibial claw, Gr=2-4	This means there are 2-4 prongs to the palpal tibial claw
Subterminala or parasubterminala more often branched or absent than nude.	These are specialized setae of the pedal tarsi. As according to Vercammen-Grandjean's statement they may be absent or present, and if present, then branched or nude, they can clearly be allotted no diagnostic significance.
Always at least one mastitarsala or a solenidion (s) on leg 3. Stigmatae (sic) and tracheae present (S+T).	Vercammen-Grandjean, in the same work, also uses S and T with other meanings.
Ch – $\frac{d}{d}$, $\frac{o}{v}$, or $\frac{d}{v}$, never $\frac{o}{o}$.	The code Ch refers to the chelicerae. The notation $\frac{d}{o}$ etc., is not explained, but presumably refers to the presence or absence of dorsal (d) or ventral (v) teeth on the cheliceral fang. The second $\frac{d}{d}$ is presumably an error for $\frac{d}{v}$, as both dorsal and ventral denticles are often present to the fang in *Odontacarus*.

Vercammen-Grandjean (1968, p. 120) then proceeded to divide *Odontacarus* into *Odontacarus* s. str., and two new subgenera, *Taralacarus* and *Leogonius*. He offered no definition for *Odontacarus* s. str., commenting "The subgenus *Odontacarus* s. str. is of no concern in this study", doubtless on the (implied) grounds that it was not represented in the "Far East" (a term which was used to include Australia, Malaysia, and eastern Asia more generally). *Odontacarus* s. str. was also omitted from the diagnostic key given on p. 53 of the same work. Reference to that key shows that *Tarsalacarus* is separated by being a section of *Odontacarus* sens. lat. in which leg tarsus III has a dorsal solenidion (solenoidala), while in *Leogonius* tarsus III lacks such a seta "but there is 1 mastitarsala and 2 mastitibialae" to leg III of the larva. Additional characters are listed for *Tarsalacarus* and *Leogonius* by Vercammen-Grandjean in that work (pp. 53, 121). Perusal of the characters listed shows that many of these are shared in common, or are overlapping, e.g. "*Odontacarus* of median (sic) size" as against "*Odontacarus* of medium to large size", or "Gr 2-4" (i.e. 2-4 claws to palpal tibia). The only characters listed by Vercammen-Grandjean as being distinct between the two subgenera, apart from that listed above, is Ch=O/v for *Tarsalacarus*, and Ch=d/O for *Leogonius*, i.e. *Tarsalacarus* has ventral cheliceral denticles but lacks dorsal ones, while the reverse situation is stated to apply in *Leogonius*. Onychotrichs (cilia to the pedotarsal claws) are not mentioned.

The subgeneric classification has been clarified and corrected by Goff and Loomis (1977), who defined *Odontacarus* s. str. as "*Odontacarus* larvae lacking tarsala III [i.e. a solenoidala]; mastitarsala III present or absent", and *Tarsalacarus* as "*Odontacarus* larvae with tarsala III; mastitarsala III absent; onychotriches absent". *Leogonius* was redefined by Goff (1979a), the diagnosis including: onychotriches on both claws and empodia; cheliceral blade with dorsal and ventral teeth; 2-3 mastitibialae III present, with basal barbs; mastitarsala III present, with basal barbs.

By the above definitions therefore, the species (as larvae) considered in the present paper come within *Leogonius*, as in fact all Australian, New Guinea and South-East Asian species have been placed by previous authors, since the subgeneric division of Vercammen-Grandjean.

The characters of the subgenera of *Odontacarus* are shown in the following Table 13.

Classification of Adults and Nymphs of Odontacarus

As this is the first description of an adult *Odontacarus*, confirmed by experimental rearing, it is appropriate here to examine the status of other adults that have been placed in this genus on the basis of morphological similarity to nymphs reared from larvae. So far seven nymphs have been allotted to *Odontacarus* by such experimental rearing, these being:

(1) *O. arizonensis* (Ewing), from North America, reared by Crossley (1960, p. 196). This species has since been replaced in *Acomatacarus s. str.* by Vercammen-Grandjean (1968).

(2) *O. plumosus* (Greenberg, 1951). This binomen was used by Brennan and Jones (1959), Loomis and Crossley (1963) and Nadchatram (1963).

A separate genus name, *Xenacarus* Greenberg, 1951 (since replaced by *Xenodontacarus* by Loomis and

TABLE 13. DIFFERENTIATING CHARACTERS OF THE SUBGENERA OF *ODONTACARUS* (+ PRESENT, – ABSENT) (SEE TEXT FOR FURTHER EXPLANATION)

Code	*Mastitibialae III (MaTiIII)*	*Mastitarsalae III (MaTaIII)*	*Solenotarsala III (SoTaIII)*	*Onychotrichs*	*Cheliceral denticles*
Subgenus					
Odontacarus	–	±	–	±	d/v
Tarsalacarus	–	–	+	–	O/v
Leogonius	±	+	–	+	d/v

Goff, 1973, on grounds of pre-occupation) has been allotted to this species, which was reared to a nymph by Crossley (1960, p. 197). Since Loomis and Goff (1973), as well as Vercammen-Grandjean (1973a) confer full generic status on this and related species, we may exclude it from immediate consideration.

There are thus five species of trombiculid mites which have been reared experimentally from the larval to the nymphal stage, which may be placed in the genus *Odontacarus* in the sense of Goff (1979a, b). These are:

(3) *O. (Leogonius) australiensis* (Hirst, 1925) from Australia and New Guinea, reared by C. B. Philip (in Womersley, 1945) from New Guinea material, and by Domrow (1956) from Australian material.

(4) *O. (L.) adelaideae* (Womersley, 1944), from southeastern Australia, reared by the present author (unpublished).

(5) *O. (L.) audyi* (Radford, 1946), from India, Thailand and Malaya, reared from Malayan material by Nadchatram (1963).

(6) *O. (L.) novaguinea* (Womersley, 1944) which was reared from larvae by G. M. Kohls in New Guinea in April, 1944 (in Womersley, 1945).

(7) *O. (L.) longipes* (Womersley, 1945), which was reared from larvae taken from *Podargus* sp. by G. M. Kohls, Dobadura area of Papua New Guinea, 25 July "1940" (probably 1944); recorded in Womersley (1945). (This species was synonymized with *O. (L.) novaguinea* by Goff (1979a, p. 149). Nevertheless the nymphs were stated by Womersley to differ significantly from those of the latter species, and this was not resolved by Goff (*loc. cit.*). It is therefore proposed to retain these two species as separate at present.)

Womersley thus in 1945 had sound grounds to define the post-larval characters of *Odontacarus* (as *Acomatacarus*), and to allot to it several species of adult mites whose previous taxonomic placings had been largely conjectural, these being, as Womersley stated (1945, p. 98) "...*Rhyncholophus attolus* Banks 1916, *R. retentus* Banks 1916, both considered [Womersley] (1934) as *Microtrombidium*, and *Dromeothrombium dromus* Wom. 1939, the last now being shown to be really two species" (Womersley, 1945, p. 109, erected *Acomatacarus patrius* to accommodate this second species).

It is very curious that, despite the widespread distribution of *Odontacarus* (*s.l.*, to include also *Acomatacarus*) in North America, Asia and Australia, adults of this genus have been recorded only from the Australian continent. This would suggest, *inter alia* (when combined with the small amount of information on their ecology), that the adults live obscure and presumably subterranean lives. Thus the adults of *O. swani* recorded here were found in soil in rain-forest, and the original specimen of *O. patrius* (Wom., 1945) was collected under a stone, in mallee country, about 7 miles west of Murray Bridge, South Australia, on 25.v.1938 by the present author, and was recorded as "white in life" which would suggest that that instar at least is spent in darkness. Four species, *O. attolus* (Banks, 1916), *O. dromus* (Womersley, 1939), *O. retentus* (Banks, 1916) and *O. patrius* have been recorded as being associated with ants, and in fact these are the only records of capture of these species apart from the above-mentioned record for *O. patrius*.

All known species of larvae in the genus have 2+2 eyes, which is consistent with their mode of life as ectoparasites upon terrestrial vertebrates. Goff (1979a) considers that the New Guinea larvae are principally ectoparasites of birds, although elsewhere there are records of these larval mites from mammals and lizards. In the case of the adults, eyes are stated to be absent in *O. swani* (see earlier), *O. dromus* (see Womersley, 1945, p. 110), and *O. patrius* (see Womersley, *loc. cit.*).

In the case of *O. attolus*, Banks (1916, p. 225) stated that this species had 1+1 eyes, but Womersley (1945, p. 108) stated that they "are not now visible"; he made a similar statement in 1934 after examining freshly mounted specimens. Careful reexamination of the type material using phase microscopy techniques (not available to Womersley) also fails to reveal evidence of eyes, nor was the writer able to see them in October, 1946, when the mite had been remounted by Womersley at some indeterminate time beforehand. It may therefore be concluded that this species lacks eyes.

The only adult species for which previous authors have agreed on the presence of eyes is *O. retentus* (Banks, 1916), for which Banks (1916, p. 116) recorded "one eye each side", whereas Womersley (1945, p. 106) recorded "Eyes present, 2+2, small, on distinct ocular shields...". Re-examination of the type material confirms Womersley's description.

This species differs also in having idiosomal setae which are terminally forked or branched. Its taxonomic placing has been even more uncertain than that of the other species mentioned by Womersley (see above). In fact Womersley placed it in *Microtrombidium* (subgenus *Enemothrombium*) in 1934, and in *Calothrombium* in 1937.

For this species, I therefore erect a genus *Scopitrombium* nov. (see further below) within the Trombiculidae, subfamily Leeuwenhoekiinae.

Genus ***Scopitrombium*** nov.

Type species (original designation) *Rhyncholophus retentus* Banks, 1916.

Definition: Adult of normal trombidioid shape, the idiosoma not constricted. Eyes 2+2, placed behind level of middle of crista. Crista broad posteriorly, narrowing anteriorly to end in a broad arrow-shaped expansion, the sagitta, provided with two normal setae. Crista with a pair of sensillary setae, filiform, at its posterior end. Palp slender. Palpal tibia with strong spine with several adjacent thickened setae. Dorsal body setae ciliate,

terminally forked or branched. Legs rather long, longer than idiosoma.

Remarks: This species is known only from the type species. It is a typical leeuwenhoekiine post-larval mite, with a well-defined sagitta to the crista. As indicated in the key below, it comes nearest to *Hannemania,* but is easily distinguished by the character of the dorsal setae. Its larval stage is unknown.

Derivation of name: The name is derived from scopi-, the root of *scopae* (f. pl.), a broom or besom, an allusion to the branched and ciliate ends of the dorsal idiosomal setae, and trombi-, the root name of the family Trombidiidae.

Scopitrombium retentum (Banks, 1916)
(Figs 8A-C, 9A-F, 10)

Synonymy

Rhyncholophus retentus Banks, 1916, p. 225.

Microtrombidium (Enemthrombium—lapsus for

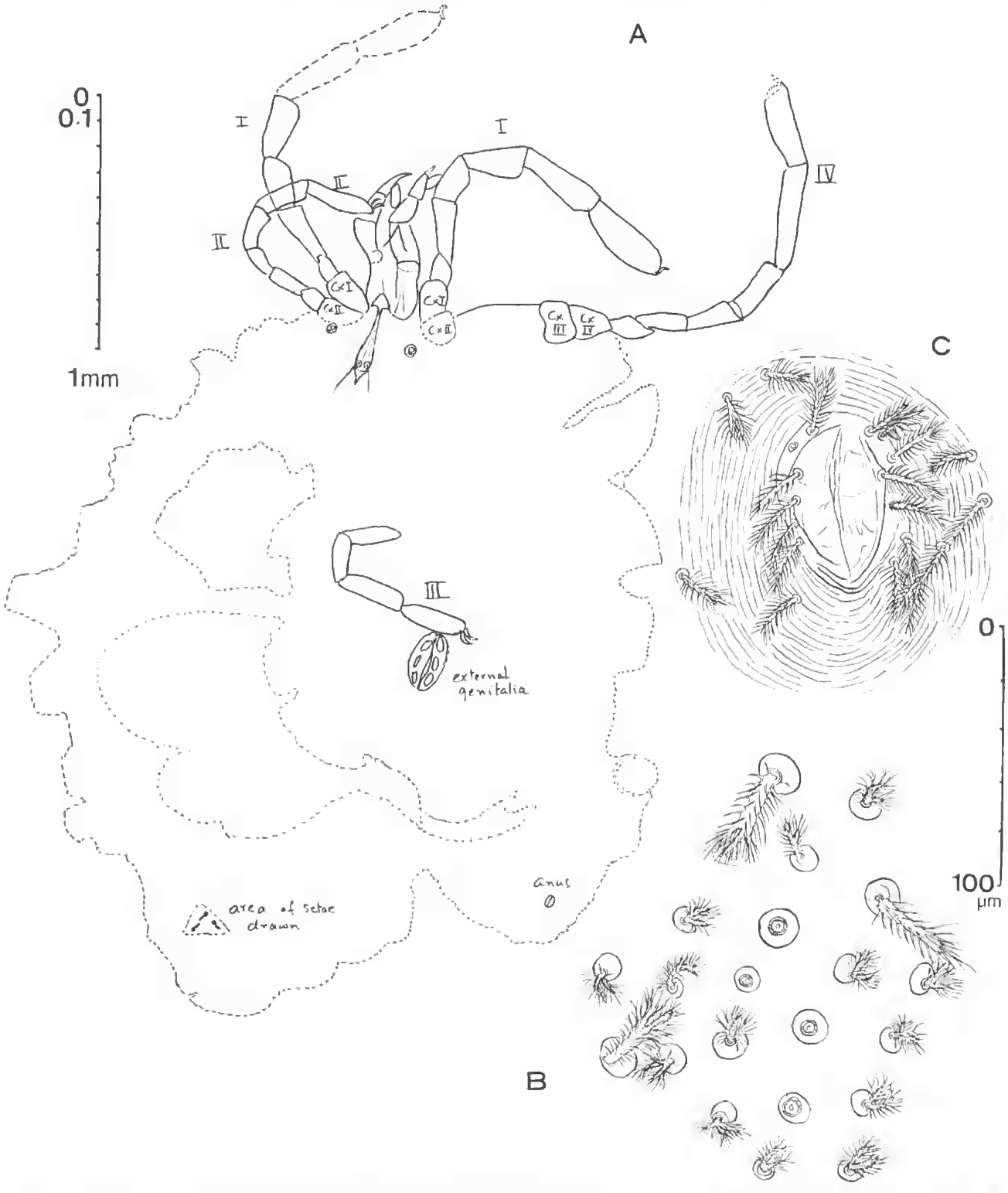

FIG. 8. *Scopitrombium retentum* (Banks), adult, lectotype. A Slide-mounted specimen seen in transparency. B Batch of posterior dorsal idiosomal setae. C Anus. (All to nearest scale.)

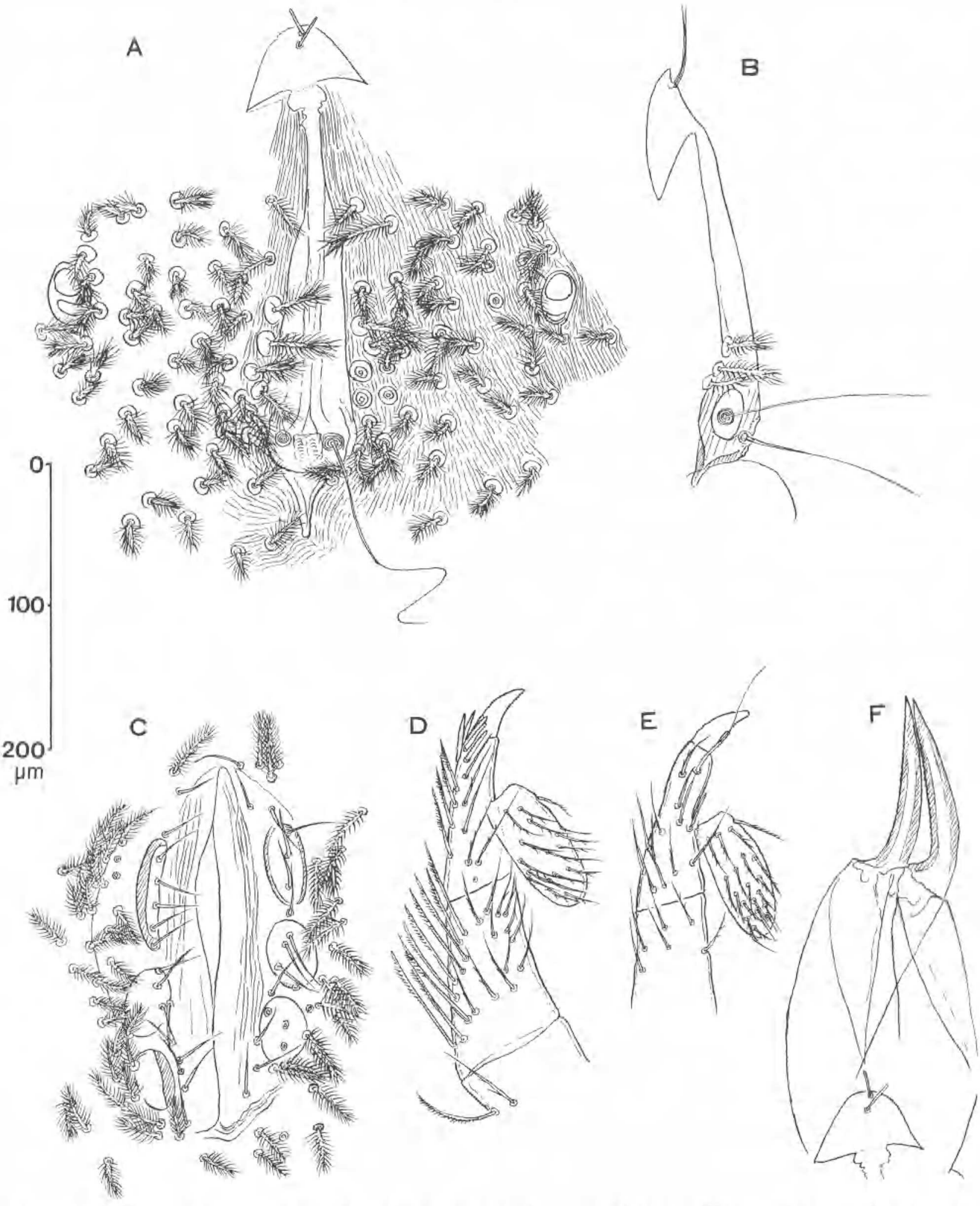

FIG. 9. *Scopitrombium retentum* (Banks). Adult. A Crista, eyes and adjacent part of dorsum. B Crista and sagitta in lateral view. C External genitalia. D Left palp, medial aspect. E Same, lateral aspect. F Chelicerae. (A, C-F from lectotype; B from ACB748). (All to scale shown.)

Enemothrombium) retentus Womersley, 1934, p. 193.
Calothrombium retentus Womersley, 1937, p. 85.
Acomatacarus retentus Womersley, 1945, p. 106. Gunther, 1952, p. 41.
Microtrombidium retentum Thor and Willmann, 1947, p. 370.

Remarks: This species was described by Banks (1916) and Womersley (1934, 1945). It was recorded originally from three localities in Victoria, in each case with a species of ant.

Hirst (1928b) was the first to point out that this was a trombidiid (*sens. lat.*) mite, not an erythraeid one

as originally described by Banks, and he assigned it to *Microtrombidium* without formally giving it a binomen. He commented (p. 1027) "This species is closely related to *M. barringunense* [Hirst, 1928a], but the tarsus of the first leg is considerably shorter . . . It is closely allied to *M. affine* [Hirst, 1928b] but has a short but distinct nasal process".

Of the three specimens, each labelled "Cotype", specimen ACB750 is the most suitable for further description, and is therefore designated the lectotype (see further below).

Redescription of Lectotype, Specimen ACB750 (Supplemented by the Two Paratypes)

The specimen in its present state is a squashed mass mounted on a 75×25 mm slide in a transparent, yellowish water-miscible medium, based on either gum chloral or polyvinyl alcohol, with picric acid used as a stain (Womersley favoured the use of picric-acid-containing media in the later 1940-1950s and possibly later). The squashed mass is the remains of the idiosoma, and is about 2.7 mm long by about 2.25 mm wide, indicating a considerably smaller original specimen (Banks recorded the specimen(s) he described as 1.3-1.5 mm long and "about one and a half times as long as broad", i.e. ca 0.9-1.0 mm broad.

Crista is a rod set in a narrow tapering scutum, widest posteriorly, and ending anteriorly in a broad sagitta; crista and sagitta with combined length of 306. Sagitta bell- or probability-curve-shaped anteriorly, borders smooth, posterior margin reflex-angled; sagitta 82 μm across by 52 deep. The corners of the sagitta are sharp (i.e. lateral angles). Sagitta bears two scobalae which are both broken off, at 21, 25 length; they are not broadened, but appear normal and almost smooth. From specimen ACB748 these can be seen to be tapered and pointed, 68 long. Sensilla bases normal, at posterior end of crista, set in a sensillary boss, centres 37 apart; sensillary setae filiform, about 180 long.

The crista and sensillary boss are invested by a narrow scutum, which tapers anteriorly, leaving the anterior third of the crista without this. The scutum is free of setae, but is set in the normal plicate idiosomal skin with its characteristic setae. Behind the sensillary boss is a conical continuation of the crista, probably subcuticular, about 50 long.

Eyes 2+2, each lateral pair set in a small oval plate about 38 long by 25 across. Anterior eye considerably the larger. Cornea 18×20, posterior eye more or less transverse, with cornea 16×9. Eyeshields set at the level of the junction of the middle and posterior thirds of the crista; centre of each eye shield about 171 distant from the midline of the crista.

Various dimensions of the type and paratypes are shown in the following Table 14.

Dorsal idiosomal setae arise from a small papilla set in a broad plate. They are heavily ciliate, more so distally, and vary considerably in length. A clear division between two distinct length-groups cannot be made. The setae tend to split or branch in about their distal third, and these branches may branch again. As all parts of the scobillum are heavily ciliate with coarse cilia, the end of the more branched setae appears commonly besom-like, these remarks applying particularly to the longer setae. In the anterior part of the dorsum there are comparatively few of the longer setae, except immediately around the sensillary area of the crista, but they are more numerous towards the posterior part of the dorsum of the idiosoma.

Ventral surface (partly from ACB749) provided with numerous but shorter ciliate setae, more uniform, and with only a slight tendency to branch terminally.

Genitalia oval, 235 long by 165 wide, with three oval suckers alongside the introitus on each side, anterior sucker 57 long by 29 wide, middle 48×34, posterior 49×36. Each valve of the external genitalia with a single row of tapering setae 32-45 long. No internal chitinization seen to genitalia, so the specimen ACB749 is possibly a female (damage to the specimen making this a little uncertain).

Anus oval, about 62 long by 51 wide, with two valves, each valve with 4-6 ciliate setae 31-35 long.

Legs moderately long and thin, appearing normal for a trombidioid mite. I 1670 long, II 1270, III incomplete, IV ca 1820 (lengths including coxae and claws). Legs with a normal degree of setation. Many of the ordinary setae (scobalae) are unilaterally and regularly ciliate, thus making them classifiable as pectinalae (see above). Dimensions of leg segments of

TABLE 14. DIMENSIONS (μm) OF SOME CHITINIZED STRUCTURES OF ADULTS OF *SCOPITROMBIUM RETENTUM* TYPE SERIES

Structure	*Identification Number*			*Womersley*	
	ACB750	*ACB748*	*ACB749*	*(1934)*	*(1945)*
Crista (including sagitta)	313	ca 285	ca 304	—	—
SB	37	—	38	—	43
TaI	362×128	347×105	—	360×90	360×110
TiI	339	334	—	315	330
GeI	245	248	—	—	—
TaIV	ca 300×97*	278×95	—	—	—
TiIV	402*	388	—	—	—
GeIV	274*	240	—	—	—
DS	16-55	20-57	18-46†	20,50	20, ~56

* This leg has been dislocated and damaged, but I presume that it has been correctly identified.
† Damaged specimen, and only a few of the longer setae are available.

lectotype: tarsus I 362 long by 128 high, tibia I 339, genus I 245, tarsus II 252×70, tibia II 245, genu II 168, tarsus III 265×86, tibia III 286, genu III 195, tarsus IV 300×97, tibia IV 402, genu IV 274 (all tarsi measured without claws). (The preceding assumes I have identified legs III and IV correctly.)

Tarsal claws sickle-shaped, unciliate, slightly blunted, appearing of normal trombidioid facies.

Palpi rather slender, normally setose. Palpal tibial claw stout, somewhat blunted. A blunted large dorso-medial accessory claw (a thickened seta) alongside claw, and several smaller thickened peg-like setae behind it. One long whip-like seta present on lateral aspect of tibia terminally, over-reaching claw. Palpal tarsus an elongate oval, with usual setation of ciliate and sensory setae.

Cheliceral fangs slender with about 12 indistinct teeth along the flexor (upper) border.

Material Examined

The only material available is the three individually mounted specimens of the original type series. Womersley stated (1934, p. 193) "As the specimens have been remounted for further examination . . . ", but only two of the specimens have been remounted from the original balsam to water-miscible medium or media. I suspect that the two slides remounted in the period 1933-1934 were remounted again in about 1944-1945, for reasons given below. Details of the three specimens are as follows:

(1) Specimen ACB750. Lectotype. Specimen mounted on a slide 75 mm×25 mm, squashed, in yellow-stained medium. The only trace of what was possibly the original labelling is a small pink label with "Cotype" in red (LHS). On the RHS of the slide is a label in Womersley's writing which reads *Calothrombium/retentus* (Banks)/Co-t [in red]/with Iridomyrmex nitidus/Ocean Grove, Vic./No. 17 Lea Coll.

(2) Specimen ACB749. A slide similar to the preceding, with the mite squashed and disrupted into three main parts and various lesser parts, in the same medium. It is labelled with a small pink label "Cotype" as in the preceding (LHS); on the RHS is a label in Womersley's writing *Calothrombium/retentus* (Bks)/ Co-t [in red] Ocean Grove, Vic./No. 17. Lea Coll.

This specimen is clearly a female, as about 20 spherical or spheroidal eggs can be counted in the fragments. These have a normally pigmented chorion, and measure about 140-195 by 120-160 in the least squashed specimens. There is no evidence of an embryo in any of the eggs. These eggs appear as normal Prostigmata-type eggs.

All legs are disrupted, and the lower (separated) part of the idiosoma retains only the trochanter I and trochanter II on one side, and trochanter IV on the other.

This slide contains fine acicular crystals which would confirm that it is mounted in a chloral hydrate-containing medium, at least in part. At the time when Womersley remounted it in 1933-1934, he was using exclusively gum-chloral media. However, a later possible use of a polyvinyl alcohol medium cannot be excluded; there is clear evidence of two zones in the mountant in the slide. The slide contains also some instar of an insect, possibly a primitive one, and also a rather stout and short trombidioid leg, different in character from the legs of *Scopitrombium retentum*. How this extra biological material got into the mountant is purely a matter for speculation.

In my opinion the specimen is in no condition to be designated a lectotype.

(3) ACB748. A slide of an almost undamaged adult mite, mounted on its side in balsam (thus indicating that the other two specimens have been remounted from balsam to water-miscible media), with a cover-glass of 19 mm diameter. It bears in the writing believed to be that of Nathan Banks (Dr E. G. Matthews, Senior Curator of Insects, South Australian Museum, who is familiar with the writing and labelling of A. M. Lea, advises that this writing is not Lea's, so it may therefore confidently be attributed to Banks.): (R.H. label) Rhyncholophus/retentus/Bks/Microthrombium [this word in Womersley's writing] /Ocean Grove/Victoria/ with Iridomyrmex nitidus/Cotype/No. (I interpret this figure as 14) 14/Lea coll.; (L.H. label) (in Womersley's writing): Calothrombium retentus (Bks)/Co-t [in red] /Ocean Grove/Vic. No. 17/Lea Coll.

As it is mounted on its side with its legs partly flexed (see Fig. 10), it is clearly not the specimen mainly used by Banks for his original description. Despite the fact that it is the only specimen in which the original data remain on the slide, it is not the most suitable to be selected as the lectotype.

Further Remarks on the Type Series and Lectotype Designation

Banks (1916, p. 226) recorded three localities for this species: Lal Lal, Ocean Grove and Sea Lake in Victoria. Despite this, all three slides are labelled "Ocean Grove, Vic." and "No. 17 Lea coll." in Womersley's writing (see above). There were clearly at least two original slides (and probably three). The remaining balsam mount (ACB748) has clearly never been interfered with. The balsam mountant has yellowed in its more peripheral parts.

According to Banks, the specimen from Lal Lal was captured with the ants of *Polyrachis hexacantha*, while the specimens from Sea Lake and Ocean Grove were captured with *Iridomyrmex nitidus*. Accepting the accuracy of the data on slide ACB748 in Banks's writing, and if we accept that the notation of Womersley on slide ACB750 about the species being "with *Iridomyrmex nitidus*" is correct, it may be deduced that this specimen, the lectotype, in fact came from Sea Lake, and that specimen ACB749 in fact came from Lal Lal. Whether we are entitled to place any

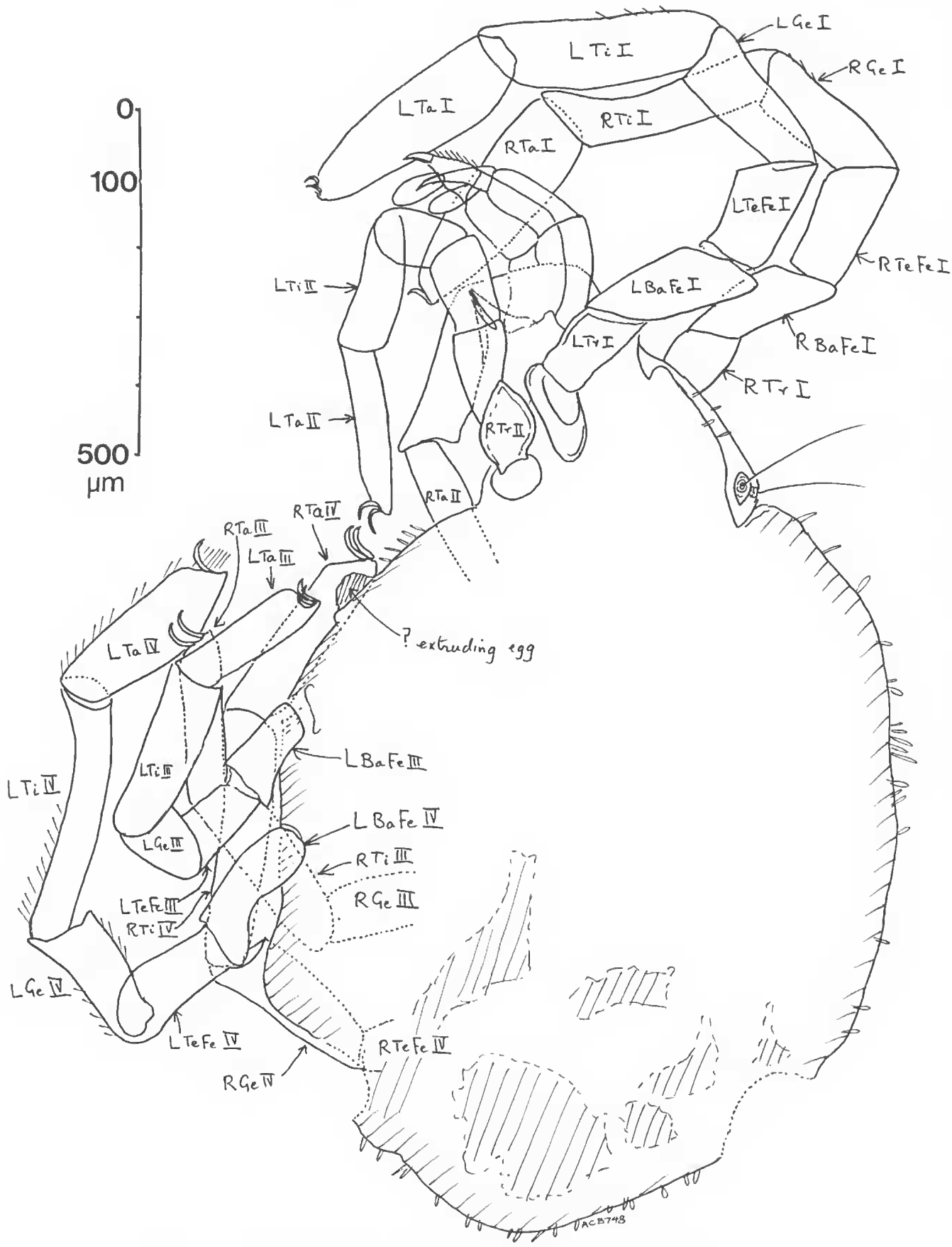

FIG. 10. *Scopitrombium retentum* (Banks). Adult, specimen ACB748, mounted on its side.

reliance upon such a deduction is conjectural, in view of Womersley's other obvious inaccuracies with data on the slide labels.

All three specimens have the distinctive type of dorsal setation recorded, and the tabular data of the chitinized parts also confirm that these three specimens are conspecific, in addition to the opinions of Banks and Womersley. For re-description, a lectotype needs to be selected. For this purpose, all three specimens in their present state have some defects. Specimen ACB748 is the only one retaining a presumably original label, but is unfortunately mounted on its side. Specimens ACB749 and 750 have been badly damaged by being remounted at some stage, undoubtedly by Womersley, and possibly at the time of his 1945 study. Despite the serious damage these latter specimens are more suitable for the usual standard descriptions used in prostigmatic and other mites, as the crista, eyes, dorsal setae and other parts remain describable.

Unfortunately Womersley was afflicted by poor vision, and he was often extremely destructive to specimens in an effort to make them easier to see. He likewise erred frequently in transcribing locality and host information and often destroyed earlier labels.

One may therefore conclude that Womersley mistranscribed the locality and other data for the two specimens ACB749 and 750, and presumably one of these came from Lal Lal, and the other from Sea Lake, but it appears there is now no way of determining which came from which.

In his writings upon this species, Womersley eventually (1945, p. 107) was aware of the three different localities in Victoria from which this species was collected, but this is unfortunately not reflected in his slide notations, which were presumably made first for his 1933-1934 study, but then re-transcribed for his 1937 study, in which he used the generic name *Calothrombium* Berlese, 1918.

There is nothing in the description and figures of Banks which allows the selection of one specimen as against the other for designation as a lectotype. Several important diagnostic characters were overlooked or misinterpreted by Banks. Thus he placed the species in the Erythraeidae, instead of the Trombidiidae (as then understood). He recorded only one eye on each side instead of two, and failed to see the sagitta to the crista. He gave almost no morphometric data, and his description of the species is such that, as far as present evidence allows, it could equally well be applied to either of these two specimens (or even three), as was probably intended by Banks in any case.

It is regrettable that Womersley re-mounted these specimens so crudely, and mistranscribed at least some of the data on the labels.

Of the choices available, I select ACB750 as the most suitable for redescription, and hereby designate it the lectotype.

Taxonomic Placing of Scopitrombium retentum

This species has had a rather chequered history of taxonomic placement. Originally it was placed by Banks in the family Erythraeidae. Correctly transferred to the Trombidiidae (*s.l.*) by Womersley in 1934, it was initially placed in *Microtrombidium* Haller, 1882, in the subfamily Microtrombidiinae, and later (1937) transferred to the genus *Calothrombium* in the Tanaupodinae. In 1945 Womersley recognized its affinities with other Leeuwenhoekiinae, and transferred it to this subfamily, which he elevated to a family, as a member of *Acomatacarus* Ewing, 1942.

The suite of characters listed above, however, set this species apart from the other members of the subfamily Leeuwenhoekiinae, and distinguish it from the Neotrombidiinae Feider, 1955, whose systematic position was clarified by Lindquist and Vercammen-Grandjean (1971).

The following is a key to the adults and nymphs of the subfamilies of the Trombiculidae (after Crossley, 1960; Lindquist and Vercammen-Grandjean, 1971) for which adults or nymphs are known.

1. Sagitta of the crista with one seta or without setae; if such a sagittal seta is present it is usually expanded somewhat or well ciliate. Palpal femur with few setae, equally numerous as, or less numerous than, in palpal genu. Sensillary setae of crista ciliate (except *Blankaartia* Oudemans, 1911) ..... Trombiculinae
   Sagitta of the crista with two setae. Palpal femur with numerous setae, more numerous than in genu. Sensillary setae of crista filiform 2
2(1) Eyes 2 + 2. Body setae conspicuously triramous. Coxa of at least the posterior leg with mosaic ornamentation. Two pairs of elongate elliptical discs or suckers to external genitalia in both nymph and adult ..... Neotrombidiinae
   Eyes 0 + 0, 1 + 1, or 2 + 2. Body setae ciliate, and may be branched or of other form, but not conspicuously triramous. Leg coxae without mosaic ornamentation. Adult with three pairs of oval discs or suckers along each side of external genitalia .. Leeuwenhoekiinae

Generic Classification of Adults and Nymphs in the Subfamily Leeuwenhoekiinae

Recent classifications of the status of the various genera and subgenera of a number of the Trombiculidae, particularly the subfamily Leeuwenhoekiinae, together with the present study of the adult of *Odontacarus*, and the separation of *Scopitrombium*, allow some revision of the generic classification.

The following is an attempt at a key to separate the genera, for the adults and nymphs, of the Leeuwenhoekiinae.

1. Eyes absent 2
   Eyes present 4
2(1) Posterior dorsal body setae in two distinct forms, the shorter spindle-shaped, pointed, ciliate, the longer sword-like, with its proximal part ciliate ..... *Odontacarus* Ewing 1929
   Posterior and other body setae tend to be locally uniform 3

3(2) Posterior dorsal setae leaflike. Legs not longer than body. Tarsus I pyriform. Cheliceral blades narrowed, nearly shearlike ..... *Whartonia* Ewing, 1944
Posterior dorsal setae somewhat expanded, but not leaflike. Cheliceral blades shearlike, not narrowed ..... *Acomatacarus* Ewing, 1942

4(1) Eyes 1 + 1 5
Eyes 2 + 2 7

5(4) Sagittal setae expanded. Cheliceral blades long and dagger-like *Xenodontacarus* Loomis and Goff, 1973
Sagittal setae not expanded. Cheliceral blades not long and dagger-like 6

6(5) Posterior dorsal setae not expanded, ciliate, and ending in long attenuated tips. Crista prominently punctate. Legs longer than body. Tarsus I cylindrical, about 2.5 times as long as high ..... *Chatia* Brennan, 1946
Posterior dorsal setae somewhat expanded, not ending in long attenuated tips. Crista a narrow rod, not prominently punctate. Legs of normal length. Tarsus I cylindrical, about 6.2 times as long as high ..... *Comatacarus* Ewing, 1942

7(4) Body constricted, to a figure-of-eight shape. Posterior dorsal setae not expanded, rather elongate and ending in a hook-like process. Tarsus I cylindrical ..... *Hannemania* Oudemans, 1911.
Body not constricted. Posterior dorsal setae terminally forked or branched. Tarsus I an elongate oval ..... *Scopitrombium* gen. nov.

In preparing the above tabular key I have accepted the separation of the Neotrombidiinae (or Neotrombidiidae) from the Leeuwenhoekiinae, proposed by Lindquist and Vercammen-Grandjean (1971).

I have also omitted the genus *Parvithrombrium* André, 1962 (whose sole species is *P. crassitarsale* André, 1962, from Angola), which its author placed in the Leeuwenhoekiidae. In the somewhat speculative revisions of the classification of the Trombidioidea which have been proposed in recent years (Vercammen-Grandjean 1973a, b; Feider 1979) the genus *Parvithrombium* has been placed in the Anomalothrombiinae Feider, 1955 (later elevated to Anomalothrombidiidae and Anomalothrombidioidea by Feider, 1979) along with *Anomalothrombium* André, 1936.

Anomalothrombium adults, the only instar known, possess a small "naso" with two setae somewhat resembling the sagitta of the Leewenhoekiidae and the Trombiculidae. This genus appears to resemble the genus *Spelaeothrombium* Willmann, 1940, and as far as descriptions allow (André, 1936, 1938, 1939, 1945, 1958; Meyer and Ryke, 1960 (for *A. curiosetosum* (Meyer and Ryke)); Robaux, 1965) could be placed in the subfamily Spelaeothrombiinae as redefined by Robaux (1968, 1972).

It appears probable that the interrelationships between these mites, at present in a state of taxonomic instability, will be clarified only when the larva-adult correlations are known, at least in the first instance.

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